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CYPLUS
CAPE YORK PENINSULA
LAND USE STRATEGY

NATURAL RESOURCES ANALYSIS PROGRAM
(NRAP)

MINERAL RESOURCE INVENTORY OF CAPE YORK PENINSULA

T.J. Denaro
Department of Minerals and Energy
Queensland

1995

CYPLUS is a joint initiative of the Queensland and Commonwealth Governments

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NR04 - MINERAL RESOURCE INVENTORY

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Note:

Due to the timing of publication, reports on other CYPLUS projects may not be fully cited in the BIBLIOGRAPHY section. However, they should be able to be located by author, agency or subject.

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CAPE YORK PENINSULA LAND USE STRATEGY
STAGE I

PREFACE TO PROJECT REPORTS

Cape York Peninsula Land Use Strategy (CYPLUS) is an initiative to provide a basis for public participation in planning for the ecologically sustainable development of Cape York Peninsula. It is jointly funded by the Queensland and Commonwealth Governments and is being carried out in three stages:

- Stage I - information gathering;
- Stage II - development of principles, policies and processes; and
- Stage III - implementation and review.

The project dealt with in this report is a part of Stage I of CYPLUS. The main components of Stage I of CYPLUS consist of two data collection programs, the development of a Geographic Information System (GIS) and the establishment of processes for public participation.

The data collection and collation work was conducted within two broad programs, the Natural Resources Analysis Program (NRAP) and the Land Use Program (LUP). The project reported on here forms part of one of these programs.

The objectives of NRAP were to collect and interpret base data on the natural resources of Cape York Peninsula to provide input to:

- evaluation of the potential of those resources for a range of activities related to the use and management of land in line with economic, environmental and social values; and
- formulation of the land use policies, principles and processes of CYPLUS.

Projects examining both physical and biological resources were included in NRAP together with Geographic Information System (GIS) projects. NRAP projects are listed in the following Table.

Physical Resource/GIS Projects	Biological Resource Projects
Bedrock geological data - digitising and integration (NR05)	Vegetation mapping (NR01)
Airborne geophysical survey (NR15)	Marine plant (seagrass/mangrove) distribution (NR06)
Coastal environment geoscience survey (NR14)	Insect fauna survey (NR17)
Mineral resource inventory (NR04)	Fish fauna survey (NR10)
Water resource investigation (groundwater) (NR16)	Terrestrial vertebrate fauna survey (NR03)
Regolith terrain mapping (NR12)	Wetland fauna survey (NR09)

Physical Resource/GIS Projects	Biological Resource Projects
Land resource inventory (NR02)	Flora data and modelling (NR18)
Environmental region analysis (NR11)	Fauna distribution modelling (NR19)
CYPLUS data into NRIC database FINDAR (NR20)	Golden-shouldered parrot conservation management (NR21)
Queensland GIS development and maintenance (NR08)*	
GIS creation/maintenance (NR07)*	

* These projects are accumulating and storing all Stage I data that is submitted in GIS compatible formats.

Research priorities for the LUP were set through the public participation process with the objectives of:

- collecting information on a wide range of social, cultural, economic and environmental issues relevant to Cape York Peninsula; and
- highlighting interactions between people, land (resource use) and nature sectors.

Projects were undertaken within these sector areas and are listed in the following Table.

People Projects	Land Projects	Nature Projects
Population	Current land use	Surface water resources
Transport services and infrastructure	Land tenure	Fire
Values, needs and aspirations	Indigenous management of land and sea	Feral and pest animals
Services and infrastructure	Pastoral industry	Weeds
Economic assessment	Primary industries (non-pastoral, non-forestry)	Land degradation and soil erosion
Secondary and tertiary industries	Forest resources	Conservation and natural heritage assessment
Traditional activities	Commercial and non commercial fisheries	Conservation and National Park management
Current administrative structures	Mineral resource potential and mining industry	
	Tourism industry	

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1.0 EXECUTIVE SUMMARY

The Cape York Peninsula Land Use Strategy (CYPLUS) is a study jointly funded by the Commonwealth and Queensland Governments to provide a basis for ecologically sustainable resource use and management in Cape York Peninsula. As part of the Natural Resources Analysis Program (NRAP) of CYPLUS, the Geological Survey Division (GSQ) of the Queensland Department of Minerals and Energy has compiled a database of known mineralisation in the CYPLUS area. Under the auspices of the National Geoscience Mapping Accord, North Queensland Project, the Geological Survey and the Australian Geological Survey Organisation (AGSO) are working jointly to update and expand knowledge of the bedrock geology, regolith, geochemistry, coastal geology and geophysics of the region.

1.1 Mining history and economic importance

Cape York Peninsula has a rich and diverse mining history dating from the discovery of gold on the Palmer River by William Hann's expedition in 1872. Population centres such as Cooktown, Coen and Weipa owe their establishment to mining. The area has produced at least 47.8 t of gold bullion, 16 078 t of cassiterite (tin) concentrates, 6171 t of wolframite and scheelite (tungsten) concentrates, 0.13 t of molybdenite, 18 000 t of copper, 1 t of silver, 4.9 t of stibnite (antimony) concentrates, 14.8 Mt of silica sand, 206 Mt of bauxite and 583 481 t of kaolin. In 1992/93, the region produced $262 316 587 worth of minerals, representing 4.7 % of the total mineral production of Queensland and 14.5 % of non-fuel minerals. This included all of Queensland's bauxite production and (by value) 98 % of kaolin, 84 % of silica, and 0.5 % of gold production. Mining is an important export earner and employer in the area.

1.2 Geological setting

The study area is divided into seven structural regions. The Coen and Yambo Inliers form the central ridge of the Peninsula and comprise metamorphic rocks which are about 1500 million years old (Proterozoic) and are intruded by granitic rocks which are about 400 (Siluro-Devonian) and 285 (Permian) million years old. The main mineral deposit types in these areas contain gold, tin, tungsten, base metals, iron, manganese and heavy minerals; coal occurs in the northern part of the Coen Inlier.

The Cape York - Oriomo Inlier forms the islands of Torres Strait and comprises volcanic rocks which are about 295 million years old (Carboniferous) and are intruded by granites of the same age. This area hosts gold, tin and tungsten deposits.

The Hodgkinson Province forms the southeastern part of the study area and extends from Cape Melville south beyond Cooktown and west to Palmerville. It comprises metamorphosed sedimentary rocks which are 500 to 360 million years old (Ordovician to Devonian) and small basins of sediments which are 290 to 270 million years old (Permian). The Hodgkinson Province is intruded by granites which are 290 to 250 million years old (Permian). The province contains gold, tin, tungsten, base metal, antimony, coal and limestone deposits. Dune fields on the east coast contain silica sand.

The Laura Basin is a sedimentary basin extending between Laura and Princess Charlotte Bay. The sandstone, conglomerate, mudstone and siltstone of the Laura Basin formed between 210 and 65 million years ago (Jurassic to Cretaceous). The basin contains known coal resources, is an important groundwater reservoir, and may contain petroleum. Cainozoic beach ridge deposits contain heavy minerals and silica sand.

The Carpentaria Basin forms the western half of the Peninsula and formed at the same time as the Laura Basin. It is an important groundwater reservoir and may contain petroleum; coal occurs in a small sub-basin, the Olive River Basin. The Karumba Basin is superimposed on the Carpentaria Basin and contains younger sediments. It hosts bauxite, kaolin, silica sand and heavy mineral deposits and is a source of groundwater.

1.3 Mineralisation

Figure 1 shows the distribution of mineralisation in the CYPLUS area. This mineralisation can be subdivided in terms of mineralising events with specific age ranges.

Proterozoic rocks of the Coen Inlier host metamorphosed stratiform/stratabound massive and disseminated base metal sulphide (copper, lead, zinc) deposits and metamorphosed stratiform/stratabound iron-manganese deposits with associated gold.

Silurian to Devonian sedimentary rocks of the Hodgkinson Province host sediment (chert)-hosted gold deposits and stratiform/stratabound volcanogenic massive sulphide deposits, and contain limestone lenses. Siluro-Devonian granites intruding the Coen Inlier are associated with gold-bearing quartz veins.

Carboniferous to Permian granites, with or without associated volcanic rocks, intrude the Torres Strait - Oriomo Inlier, Coen Inlier and Hodgkinson Province. These granites and volcanics are associated with gold (+base metals) in veins and breccias, tin in veins and greisens, and tungsten in veins and skarns. At about the same time as these granites were intruded, gold and antimony-bearing quartz veins were formed during deformation of the Hodgkinson Province. Small coal deposits were formed in small sedimentary basins in the north of the Coen Inlier and in the Hodgkinson Province in the Permian.

Significant coal deposits occur in the Mesozoic Laura Basin. The Laura and Carpentaria Basins may contain petroleum.

During the Cainozoic, bauxite and kaolin deposits formed in the Karumba Basin. Shoreline deposits such as beach ridges and sand dunes contain heavy minerals and silica sand. Alluvial deposits contain gold, tin and heavy minerals. Diamond pipes may be associated with basaltic volcanism in the Lakeland Downs area.

1.4 Known and potential resources

The CYPLUS area contains significant economic resources of bauxite, kaolin and silica sand. There is also a high potential for the discovery and development of gold, tin, tungsten, coal, limestone and heavy mineral deposits. The area also contains known resources of iron, manganese, antimony and base metals (copper, lead, zinc). There is

some potential for the discovery of gemstones (diamonds, sapphires) and petroleum. The Carpentaria, Laura and Karumba Basins are important groundwater reservoirs. In places, groundwater is also available from fractured rocks of the Coen, Yambo and Cape York - Oriomo Inliers and the Hodgkinson Province and from Recent alluvium.

Figure 1

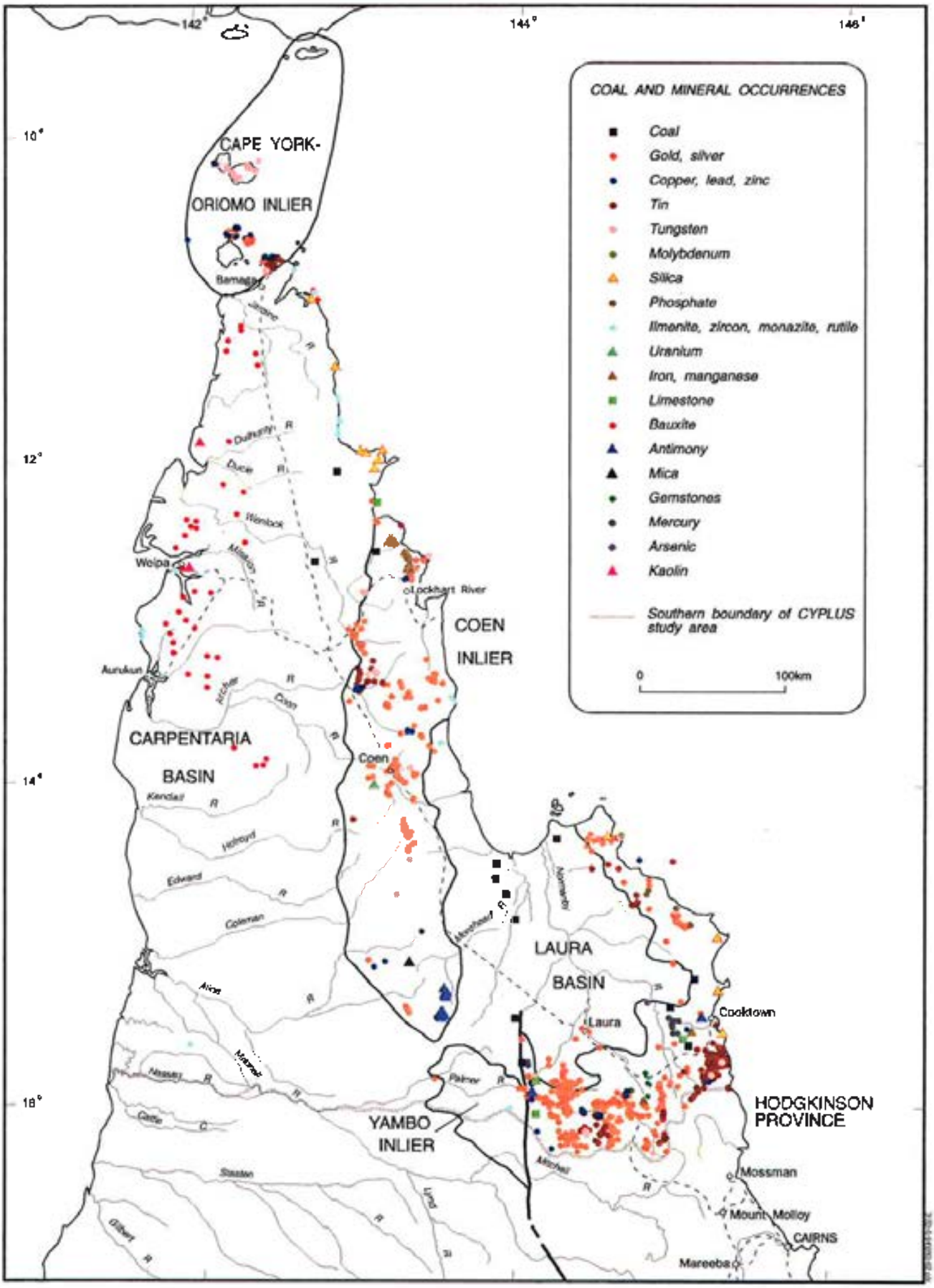

Figure 1: Distribution of mineral occurrences

2.0 INTRODUCTION

The Cape York Peninsula Land Use Strategy (CYPLUS) is a jointly funded initiative of the Commonwealth and Queensland Governments. Its objective is to provide a basis for ecologically sustainable resource use and management in Cape York Peninsula through:

a) gathering and interpreting data on the natural and cultural resources and key values of the Peninsula; and
b) establishing a strategy for land use policies and decision making principles.

The strategy is being developed in three stages:
Stage I, which comprises information collection and public participation, will be completed by the end of 1994.
Stage II is the development of principles, policies and a decision-making framework and will be completed by the end of 1995.
Stage III comprises the implementation and evaluation of the framework and is ongoing.

The keystone of the strategy is the Natural Resources Analysis Program. Data are being collected on the fauna, flora, geology, mineral resources, water resources and land uses of the Peninsula and will be compiled into a Geographic Information System (GIS). Public participation is an underlying philosophy of the strategy, allowing Peninsula residents and other stakeholders to provide and obtain information and to have an effective input to the development of the strategy.

The Geological Survey Division (GSQ) of the Department of Minerals and Energy is contributing directly by providing an up-to-date database on the mineral resources of the study area. Under the auspices of the National Geoscience Mapping Accord (NGMA) North Queensland Project, the GSQ is working jointly with AGSO (the Australian Geological Survey Organisation; formerly the Bureau of Mineral Resources, Geology and Geophysics) to update and expand knowledge of the bedrock geology, regolith, geochemistry, coastal geology, geophysics and mineral resources of the region.

This report summarises the results of Project NR04 (Mineral Resource Inventory) of the Natural Resources Analysis Program.

3.0 METHODOLOGY

3.1 Mineral resource inventory

Von Gnielinski and others (1991) prepared preliminary mineral occurrence data for AGSO from company reports covering the period 1969 to 1980. Mineral production statistics and historical data on individual mines have been compiled for the Palmer Goldfield (Burrows, 1991) and the Cooktown, Weipa and Thursday Island Mining Districts (Dugdale, 1991). Culpeper and others (1992a) prepared a summary of mineral exploration results for the period 1969 to 1990. Denaro and Culpeper (1992) have provided an overview of the known mineral resources and mineralisation styles in the area. Blake (1991) has reviewed the geology and mineral and energy resources of the sedimentary basins in the area and Denaro and Shield (1993) reviewed coal and petroleum exploration within the CYPLUS area.

Mineral occurrence mapping on a systematic 1:100 000 and 1:250 000 Sheet area basis commenced in 1990. Information has been compiled on 1490 mines (both current and abandoned), prospects and mineral occurrences. This information was gathered from reports, maps and records which are publically available through the Department.

Fieldwork was carried out to accurately locate old mine workings, map the workings, and record information on the local geology. Some sampling (generally from old mine dumps) was carried out to assist in identification of minerals and rock types.

Reports have been prepared on individual map sheet areas (Figure 2). These reports contain information on the geology, mining history, exploration results and mineral deposit types within each sheet area, and also include mineral occurrence location maps. Table 1 lists the relevant reports, which can be purchased from the Information Services Branch, Department of Minerals and Energy, GPO Box 194 Brisbane, 4001 (tel [07] 237 1434, fax [07] 221 9517); these reports can be inspected in the Department of Minerals and Energy library, 5th floor, 61 Mary Street, Brisbane.

3.2 Mineral resource assessment

The Mineral Resource Inventory Project has provided essential information on the distribution, types and geological setting of mineral deposits, past production and grades, and exploration results for input to an assessment of the mineral resource potential of the CYPLUS area (Denaro & Ewers, in preparation) as part of the Land Use Program of CYPLUS. This assessment is concerned with the probability of mineral occurrence, particularly mineral occurrences of sufficient size and grade to constitute an economic (mineable) resource, based on current concepts and data. Qualitative assessment methods developed by the United States Geological Survey are being used.

Figure 2

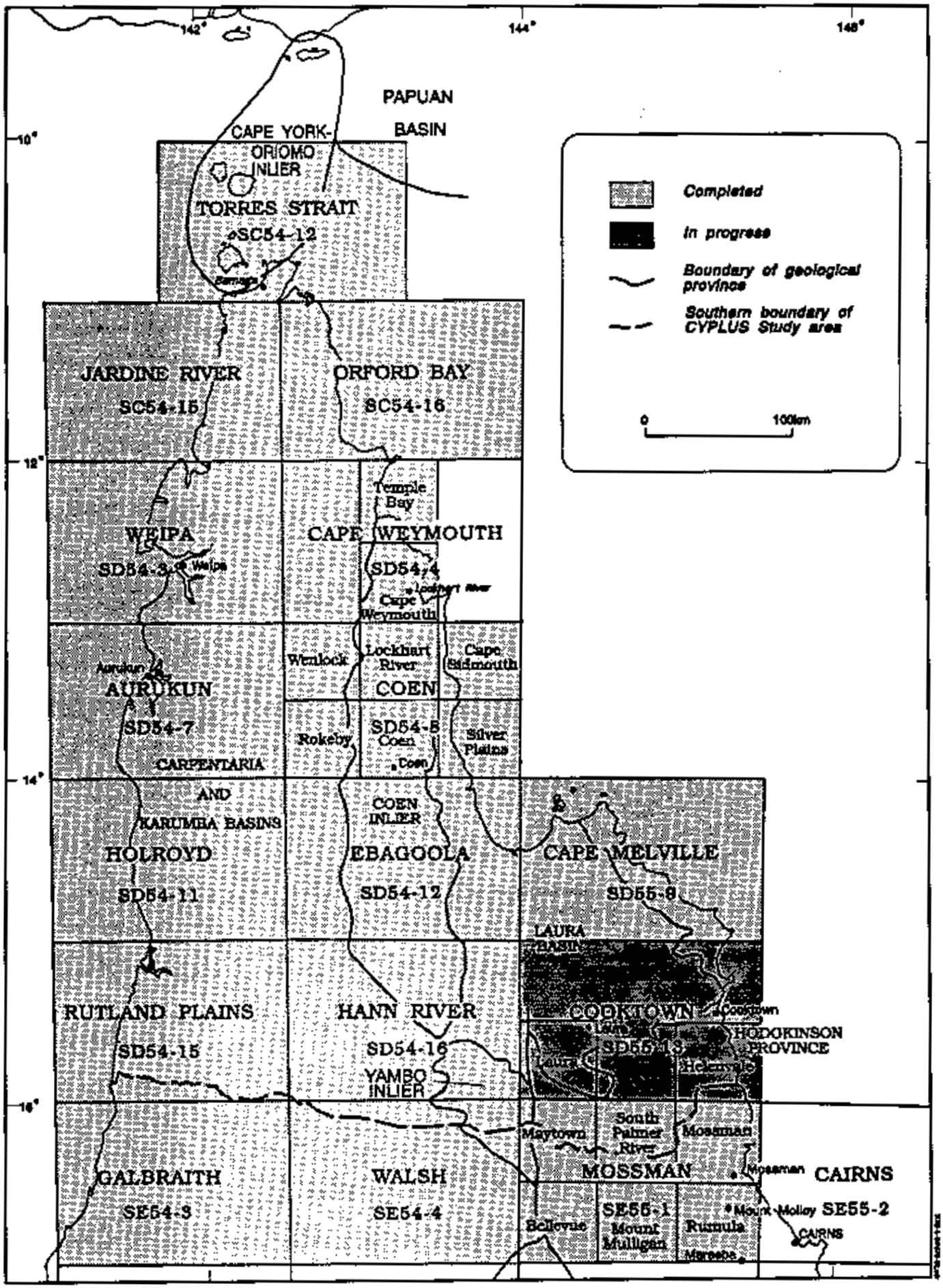

Figure 2 : Location of study areas for individual mineral occurrence reports.

Table 1: Mineral occurrence reports, CYPLUS area

Sheet area(s)	Report
Torres Strait 1:250 000	Denaro (1993)
Jardine River, Orford Bay, Weipa, Cape Weymouth (part), Aurukun, Holroyd, Rutland Plains, Galbraith and Walsh 1:250 000	Culpeper (1993)
Temple Bay 1:100 000	Denaro & Morwood (1992a)
Cape Weymouth 1:100 000	Bruvel & Morwood (1992)
Wenlock 1:100 000	Denaro & Morwood (1992c)
Lockhart River and Cape Sidmouth 1:100 000	Denaro & Morwood (1992b)
Rokeby, Coen and Silver Plains 1:100 000	Denaro & others (1993)
Ebagoola 1:250 000	Culpeper & others (1992b)
Hann River 1:250 000	Culpeper & Burrows (1992)
Cape Melville 1:250 000	Denaro & others (1992)
Laura 1:100 000	Denaro & others (in preparation)
Helenvale 1:100 000	Denaro & others (in preparation)
Cooktown, Butchers Hill, Battle Camp and Kennedy Bend 1:100 000	Culpeper & others (in preparation)
Maytown 1:100 000	Lam & others (1991)
South Palmer River 1:100 000	Lam & Genn (1993)
Mossman 1:100 000	Lam (1993)

Outputs from this study will include a comprehensive report on the geology and mineral resources of the CYPLUS area and maps and a GIS layer showing the location of areas with potential for particular mineral deposit types. This report is being prepared jointly by the Department of Minerals and Energy and the Australian Geological Survey Organisation.

Information on the probability of mineral occurrences will assist to:

- identify areas where current or likely land tenures may restrict mining of potentially valuable resources;
- identify areas where there may be potential for conflict between mining and other land uses;
- better define areas where mineral exploration may be successful.

The resource assessment report will provide valuable input to a report on mining industry issues for use in Stage 2 of CYPLUS.

3.3 Databases and GIS

Mineral occurrence data have been compiled and entered into the Department of Minerals and Energy's Mineral Occurrence (MINOCC) database. This database is currently running under FOXBASE software. For dissemination via magnetic media, data are provided in ASCII format or in an Aston-Tate database file structure. The database can be manipulated by software such as DBASE, DBXL, FOXBASE, QUICKSILVER and RBASE. The ASCII file is exported directly from the DBF structure. MINOCC data will soon be converted to the Arc/Info-ORACLE environment of the Department's Geological Resources Data Base (GRDB).

The database includes information on the location, history, production, geological setting, extent and type of workings, mineralisation characteristics and published results of past exploration.

The data have been converted to Arc/Info for inclusion in the CYPLUS GIS. Some fields in the original database have not been included in the CYPLUS database because they either:

a) are not necessary in the graphical environment of Arc/Info;
b) provide detailed information which is not essential for CYPLUS; or
c) are comments fields which are not readily searchable in Arc/Info.

The full data set is available from the Department of Minerals and Energy and is included in the hard copy mineral occurrence reports. The structure of the CYPLUS data set and definitions of terms used are given in Appendix 1. Assay results for gold are generally given in terms of the units grams per tonne (g/t) or parts per million (ppm); these units are subtly different and the units quoted depend upon the assay method used.

The results of the mineral resource assessment will be included in the CYPLUS GIS as a layer delineating areas with potential for particular mineral deposit types of a specified size.

4.0 MINING AND EXPLORATION

4.1 Mining history

Cape York Peninsula has a rich and diverse mining history. The CYPLUS area has produced at least 47.8 t of gold bullion, 16 078 t of cassiterite (tin) concentrates, 6171 t of wolframite and scheelite (tungsten) concentrates, 0.13 t of molybdenite, 18 000 t of copper, 1 t of silver, 4.9 t of stibnite (antimony) concentrates, 14.8 Mt of silica sand, 206 Mt of bauxite and 583 481 t of kaolin.

The early mining history of Cape York Peninsula has been summarised previously by Willmott & others (1973) and de Keyser and Lucas (1968), and in the Explanatory Notes for the relevant 1:250 000 geological sheets. Detailed information is included in the mineral occurrence reports for individual Sheet areas. Production figures (Table 2) are based on those in the mineral occurrence reports and on compilations of mineral production statistics by Burrows (1991) and Dugdale (1991).

Figure 3 shows the early Gold and Mineral Fields and the recently superceded Mining Districts. Most of the study area is now within the newly expanded Mareeba Mining District.

4.1.1 Gold

In 1872, William Hann led an expedition into Cape York Peninsula to investigate the mineral and pastoral potential of the region. Frederick Warner, a surveyor, was credited with the first discovery of gold on the Palmer River. The reported occurrence of gold over a wide area along the Palmer attracted the attention of miners in the Georgetown area. In 1873, a group of prospectors led by James Venture Mulligan spent two and a half months prospecting along the Palmer and its tributaries, during which time 102 ounces of gold was recovered. The group returned to Georgetown to report the discovery and to claim the Government reward of 1000 pounds for discovering payable gold in a new field. Their report sparked the greatest gold rush ever seen in Australia. Maytown sprang up and became the administrative centre for the whole of the Peninsula. Smaller settlements such as Lukinville, Palmerville, Echo Town, Revolver Point, German Bar, Stonyville, Byerstown and Uhrstown were established in outlying areas. Cooktown was established at the mouth of the Endeavour River to service the goldfield and, within months, became one of the busiest ports in Queensland.

Table 2: Recorded mineral production, Cape York Peninsula

Gold

Location	Production period	Ore (t)	Tailings (t)	Lode gold (kg)	Alluvial gold (kg)
Alice River Gold and Mineral Field	1903-1909, 1912-1916, 1936	2651		101.1	14.0
Potallah Creek Gold and Mineral Field	1902-1904, 1914, 1942, 1947	668		21.8	0.16
Hamilton Gold and Mineral Field	1900-1951	34196	19256	1371.6 237.5	682.5
Coen Goldfield	1876-1880 1892-1918, 1952	>29244	20000	2799.8 412.4	>310.0
Klondyke area	1898-1904	784		41.4	
Lochinvar Provisional Mining Field	1904	50		2.2	
Blue Mountains	1934-1945, 1948-1951	>1390		51.4	0.14
Leo Creek (Claudie Lakeland)	1896-1904, 1909-1910	595		87.5	

Location	Production period	Ore (t)	Tailings (t)	Lode gold (kg)	Alluvial gold (kg)
Rocky River Goldfield	1893-1896				38.75
Mullumbidgee	1952-1957	7		2.2	
Hayes Creek Provisional Goldfield	1909-1914, 1934, 1938-1953	529.7		28.3	0.37
Wenlock Gold and Mineral Field and adjacent area	1892-1894, 1905-1951, 1964-1965, 1977-1978	14958.5		312.1	>1215.35
Battery Lease	1903, 1910-1913	144		6.8	
Claudie River Gold and Mineral Field	1934-1942	17099	3220	333.1	
Possession Island Gold and Mineral Field	1897-1902, 1905, 1919	>4261		113.1	
Horn Island Gold and Mineral Field (including Hammond and Thursday Islands)	1894-1900, 1909, 1935 1988-1989	16906		179.44 1432.0	31.07

Location	Production period	Ore (t)	Tailings (t)	Lode gold (kg)	Alluvial gold (kg)
Starcke No. 1 Goldfield (Cocoa Creek)	1892-1896	1157.2		34.5	
Starcke No. 2 Goldfield	1890-1913	5964	457	314.0 2.2	117.5
Six Mile Creek	1921, 1939-1948	111		2.69	
Palmer Goldfield (including West Normanby field)	1874-1990			4340.5	>33210
	Total:			>12227.6	>35619.8

Tin

Location	Production Period	Lode tin (t cassiterite concentrates)	Alluvial tin (t cassiterite concentrates)
Granite Creek (Coen area)	1907-1931, 1938-1940, 1977-1978		333.5
Tin Creek and First Stony Point tinfields	1900-1928, 1938-1940		14
Cape York tinfield	1950-1986	>15.6	>21.5
Barrow Point	1939		0.25
Howick Island			0.50
Cooktown Tinfield	1885-1992	272	12578
Palmer Goldfield (Granite Creek, Cannibal Creek, Mount Windsor Tableland)	1880-1884, 1900-1937, 1948, 1958, 1969, 1970	37.6	2805.5
	Total:	>325.2	>15753.25

Tungsten and molybdenum

Location	Production Period	Lode tungsten (t wolframite concentrates)	Lode tungsten (t scheelite)	Lode molybdenum (t molybdenite)
Grand Final (12 km east of Coen)	1904, 1915-1918, 1952 1915-1917	5.8		0.13
Bowden Mineral Field	1904-1916, 1952	70.3		
Moa Island	1938-1956	100.6		
Portlock Island	1951	0.03		
Howick Island	?1921	0.25		
Noble Island	1904-1912, 1916	18.7		
Cooktown Tinfield	1889-1902, 1919, 1921, 1955-1957	8.3		
Palmer Goldfield (Spring Creek)	1907 1969-1970	0.2	5966.7	
	Total:	204.18	5966.7	0.13

Copper

St George Copper mines: 1905 to 1907, 5 t of 24 % ore
Dianne Copper Mine: 1980-1983, 69 820 t ore, >18 000 t Cu and 1000 kg Ag

Antimony

Six Mile Creek, west of Cooktown: 1944-1945, 7 t of ~58% ore
Uncle Sandy mine, Starcke No. 2 Goldfield: 1906, 9 t of 9% ore

Silica sand

Cape Flattery Silica Mine: 1968 to 1993, 14.8 Mt

Bauxite

Weipa Bauxite Mine: 1960 to 1993, 206 Mt

Kaolin

Weipa Bauxite Mine: 1986 to 1993, 583 481 t

Figure 3

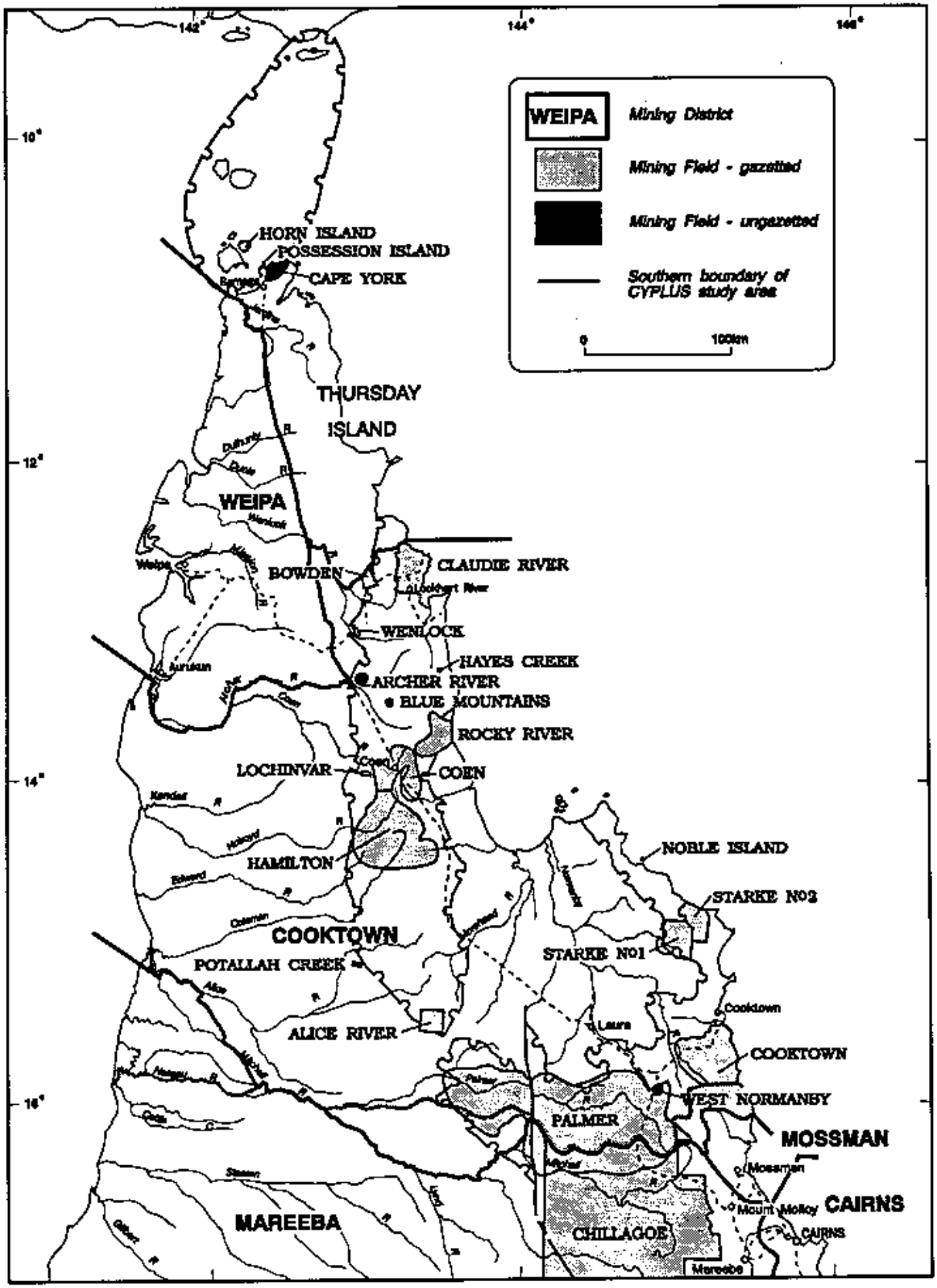

Figure 3: Historical Mining Districts and Fields of Cape York Peninsula

Alluvial gold mining commenced soon after the announcement of Mulligan's find and the Palmer Goldfield, covering 8934 km^2, was gazetted in November 1873. Alluvial deposits were mined in the North Palmer, Palmer, South Palmer and West Normanby Rivers and their tributaries, and in the headwaters of the Mosman River and Kennedy Creek. Gold was readily recovered from shallow alluvium at depths of less than 1 m, and the average daily yield was 70 g per miner. Adverse conditions, including water problems, remoteness and the high cost of cartage and supplies, prevented the rich ground from being worked out within the first year of discovery. By 1874, it was estimated that 10 000 miners were on the field. By the end of 1875 many outlying creeks and gullies were also being worked and the population was approaching 20 000. In 1877, more than 90 % of the population was Chinese. By the end of 1883, most of the alluvial gold had been worked out and the Chinese population had dropped to about 1000. Aspects of the colourful history of the Palmer Goldfield have been recorded by Holthouse (1967).

The presence of large numbers of miners on the Palmer field, as well as the establishment of a permanent settlement at Cooktown, led to the discovery of a number of important goldfields on the Peninsula. In 1876, prospectors discovered gold at the site of Coen township. Subsequent prospecting and exploration led to further gold discoveries (and gold rushes) near Cooktown, at Hayes Creek, near Coen, on the Wenlock and Rocky Rivers, in Torres Strait, at Ebagoola and Alice River, and in the Iron Range area. Most of these fields commenced as alluvial fields but, except on the Palmer field, the alluvial rushes were generally short lived because there was insufficent material of a high enough grade to support large numbers of alluvial miners.

Subsequently, rich quartz reefs were discovered on most fields and there was a revival of gold mining. Generally, mining was hampered by the isolation of the fields, the high cost of cartage, outdated treatment techniques, and problems with keeping the deeper workings dewatered. Reef mining continued spasmodically up until the Second World War when the mines were closed and much of the machinery was removed to prevent it falling into Japanese hands in the event of an invasion. Attempts to reopen the old workings after the war were generally unsuccessful.

In the late 1970's, a number of companies mined alluvial gold in the Palmerville, Mammoth Bend and Four Mile Bend areas on the Palmer River and on the West Normanby River.

In the early 1980's, a sharp increase in the gold price drew the attention of Australian Diversified Resources Ltd and Rimeki Pty Ltd to the Palmer River area. Subsequently, these companies (in joint venture with AUR N.L.) mined McGann, Stony and Sandy Creeks, and the gullies draining Mount Madden. Alluvial gold output increased sharply from 1985. Production by these companies was 1190 kg from 1985 to 1989.

Falling tin prices in the mid 1980's compelled many alluvial tin miners to rework the Palmer River and its tributaries for gold. Early results were mixed, mainly due to competition for ground and the inefficiency of converting tin concentrators to trap the very fine-grained gold in the river wash. Lam and others (1991) estimated that >2500 kg of gold was produced from the Palmer Goldfield from 1980 to 1990.

In 1986, an area from the Palmer River (including the old Maytown township) to north of the R.L. Jack memorial on top of the Conglomerate Range was proclaimed as the Palmer Goldfields Reserve. The reserve is jointly administered by the Department of Minerals and Energy and the Department of Environment and Heritage (Queensland National Parks and Wildlife Service Branch).

Torres Strait Gold Pty Ltd opened up the Horn Island Gold Mine in 1987. Mining was by opencut and treatment by fine grinding, flotation and carbon-in-leach. Some alluvial gold was also recovered from gullies draining into Spring Creek. The first gold pour was in July 1988 and commercial operations commenced in January 1989. The mine closed in December 1989 due to lower than expected ore grades and the collapse of the parent companies (Augold N.L. and Giant Resources Ltd). The leases were forfeited and the Department of Minerals and Energy has decommissioned the mine and is rehabilitating the site. Total production (1988 to 1989) was 1432 kg of gold bullion (52% gold). The area actually mined was only a small portion of the historic goldfield.

Recently, the Golden Era Goldmine Syndicate has been working reefs and alluvial gravels at Ebagoola for specimen gold (Kay, 1990).

Up until recently, Saracen Minerals N.L. and Wallace Mining were producing alluvial gold from Oscar Creek. They also worked old tailings dumps for their gold content. Saracen's mining plant was auctioned at Coen in October 1992.

Recently, there has been a revival of lode gold mining in the West Normanby field.

4.1.2 Tin

Tin has been mined in a number of areas on the Peninsula. Most of the production has come from the Cooktown - Palmer River area.

Alluvial gold miners found cassiterite associated with gold in alluvium in Cannibal and Granite Creeks, south of the Palmer River, in 1873 and 1874. Mining did not commence until 1876, following a rise in the tin price in 1875. No official production records are available for the early years. In 1879, extended areas were opened to the alluvial tin miners, resulting in a peak production of more than 1 000 t of cassiterite concentrates for the years 1880 and 1881. By the end of 1884, 2 260 t of concentrates had been produced.

Cassiterite-bearing quartz greisen lodes were discovered at Granite Creek, probably prior to 1876. Other lode systems were soon discovered at Cannibal Creek. By 1882, Cannibal Creek became the main lode tin producing centre. However, an unexpected price collapse in 1883 forced the closure of the mines.

In 1885, alluvial cassiterite was discovered in Wallaby Creek and the upper Annan River valley. Within a year, alluvial tin was being mined at several localities between Mount Amos and Mount Romeo, in the Cooktown or Annan River Tinfield, and lode mining had commenced at Mount Amos. By 1887, mining had commenced at almost all of the deposits which were to become established mining centres. Because of the mountainous

terrain, only small scale mining was possible in most areas. The main mining centres were at Rossville, Helenvale, Shiptons Flat, Tabletop, Little Tableland, Big Tableland, Mount Leswell, Mount Hartley, Mount Amos, Mount Finlayson, Mount Romeo, Mount Poverty and Slatey and Granite Creeks. The main centres for lode mining were Mount Amos (Phoenician and Dreadnought mines), Big Tableland (Lion's Den mine), Mount Leswell and Collingwood.

Production reached a peak in 1888, when 1034 t of cassiterite concentrates was won by 800 miners. The Cooktown Mining Field was gazetted in 1889. Dredging was attempted in 1892, but this and later attempts were unsuccessful. Most of the tin was obtained by hydraulic sluicing of alluvium, colluvium and decomposed (altered) granite. Water was obtained by elaborate systems of water races (and sometimes tunnels) tapping water from streams and dams at a high enough level above the workings to provide sufficient head pressure. The rugged, heavily forested terrain restricted the profitability of anything other than small-scale operations. The rich surface deposits were soon depleted by individuals and small parties.

The Annan River Company N.L. and others commenced large-scale sluicing operations in 1905. The largest mines were the Collingwood Face, Daly's Face and Home Rule. Annual production steadily declined after 1915.

Cassiterite was first discovered in Granite Creek (also known as Tin Creek), near the Archer River, by Bush, Mayers, Wilson and others in about 1887. The tin price was low and the area was abandoned until 1906. A small settlement was established in 1907.

Small deposits of alluvial cassiterite have also been worked in the Tin Creek and First Stony Point areas, north of the Pascoe River.

Alluvial cassiterite was discovered on the Mount Windsor Tableland around 1890. Mining was carried out by sluicing the large volumes of granitic alluvium in tributaries and gullies of Piccaninny Creek.

Alluvial and vein cassiterite deposits were found on Cape York by Bromage, Holland and Miller in 1948. Most production came from beach sand deposits along Punsand Bay.

In 1969, Frost Enterprises Pty Ltd mined the lodes at Cannibal Creek and produced 34.1 t of cassiterite concentrates from 37 515 t of ore. Mining ceased in 1970 because of diminishing ore grades.

Alluvial tin production increased significantly in the 1970's, following rising tin prices, and peaked in the mid 1980's. In the Palmer River area, Granite and Cannibal Creeks were mined by Buddha Gold Pty Ltd, Frost Enterprises Pty Ltd, Mirrajong Pty Ltd and Rosella Mining Pty Ltd. Alluvium from Nine Mile and Tin Creeks was hauled to a processing plant at the Adams mine. Alluvial tin was also mined in Fiery Creek. Cook brothers mined alluvium in the eastern side gullies of Granite Creek, near the Archer River.

There was a revival of small-scale mining in the Cooktown Tinfield. Moderately large-scale alluvial operations were carried out by Terrax Resources N.L. at Rossville and Serem Australia Pty Ltd at Lee Creek. Production rose significantly to peak at 250 t in 1981. The dramatic fall in tin prices in the mid-1980's caused most tin miners to seek alternative employment.

4.1.3 Tungsten and molybdenum

Wolframite has been produced from two mines in the Cooktown Tinfield. A wolframite lode was discovered at Mount Hartley in 1889 and was first worked by Symons, Fletcher and Dibney. H.C. Worrall worked the Bonny Boy claim at Clearwater (Romeo area) from 1955 to 1957.

Wolframite was discovered north of the Kennedy Road crossing of the Pascoe River by William Lakeland and William Bowden in 1892, but claims were not taken up until 1904. The Bowden Mineral Field was proclaimed in 1907; an influx of miners followed a rise in the wolfram price. The field was worked from 1904 to 1916 and again in 1952.

Wolframite was discovered on Noble Island in 1900 and Troup and party secured two leases over the deposits. Crammond and Formasini worked the deposit from 1904 to 1909. Ore was collected by picking it out of narrow veins on or near the surface.

A small deposit on the Grand Final lease, approximately 11 km east-northeast of Coen, produced wolframite and molybdenite concentrates in 1904, 1916 to 1918 and 1952.

From 1938 to 1955, the local inhabitants mined wolframite by handpicking and gouging shoad and quartz reef deposits at three main localities (Eet Hill, Blue Mountains, and near Kubin Village) on Moa Island, in Torres Strait. Most production was obtained during the Second World War and the Korean War, when the wolframite price was high. Wolframite was also mined on Portlock Island, 4.5 km northeast of Moa Island.

Approximately 15 km south of Palmerville, scheelite floaters in creek beds were recorded in the early 1900's. No other discoveries were made until 1968, when Frost Enterprises Pty Ltd discovered tungsten lodes at Spring Creek and Mount Hurford. The scheelite lodes at Mount Hurford were considered to be uneconomic to mine. The Spring Creek deposit (Keddies Lode) was mined in 1969 and 1970. Mining ceased in 1970 due to a low market price for tungsten ore.

4.1.4 Copper

Copper mineralisation was discovered at the St George Copper mines, north of Palmerville, in 1905. The St George Copper and Coal Company prospected for copper and mercury and produced 5 t of 24 % copper ore from 1905 to 1907.

Copper-stained outcrops were first worked at the Glenroy Copper mines, north of Palmerville, in 1906 and 1907 by Christie brothers, Hamilton, Baker and Morrison. Shallow prospecting shafts were excavated but there is no record of any production.

The Dianne Copper Mine deposit, near the Palmer River, was probably discovered by prospectors in the early 1880's. The lode was mined from two shallow shafts and an adit but no production was recorded for this early mining period. Due to the remoteness of the deposit and high freight costs to Cooktown, the copper ore was uneconomic to mine.

Mr R. Keddie was guided to the prospect in 1958. Uranium Corporation carried out exploration work to assess the deposit in the same year; exploration results were inconclusive.

In 1968, North Broken Hill Pty Ltd carried out core drilling on behalf of the lease holders and calculated reserves of approximately 451 000 t of oxidised copper ore at 0.86 % copper. No mining was carried out as the reserves were below the company's target. Kennecott Exploration Pty Ltd carried out further drilling in 1969.

Mareeba Mining and Exploration Pty Ltd took out an option over the deposit and calculated reserves of 90 000 t of supergene ore at 24 % copper. The company acquired the deposit in 1979 and commenced developmental work. Production from 1979 to 1983 was 69 820 t of direct shipping grade ore assaying 18 to 26 % Cu and 359 g/t Ag (Wallis, 1993b). The secondary copper ore was mined to a depth of more than 90 m, where it gave way to primary massive sulphide ore. Most of the ore was not treated at the mine, but trucked by road to Cairns for direct shipment to Japan and Korea. Because of the fall in world copper prices in 1982 and depletion of reserves, Mareeba Mining decided to terminate the operation, leaving 20 000 t of unrecovered ore. Plant, equipment and infrastructure were sold and removed.

4.1.5 Antimony

Antimony ore was discovered in a group of gold-antimony lodes at Six Mile Creek, 8.0 to 9.6 km west of Cooktown, in 1902 but practically nothing was done at that time. Holmes' Antimony lode was worked in 1921, but there is no record of any production. The Good Luck reef was worked by Bott, Butcher and Bennett in 1942. A trial parcel of hand-dressed antimony ore was sent to Sydney but returns did not indicate very high grades. In 1944 and 1945, 7 t of ore was treated in Sydney for a return of approximately 4 t antimony.

In 1906, a trial shipment of 9 t of 9% antimony ore was produced from the Uncle Sandy Mine, near Munburra in the Starcke No. 2 Goldfield.

Stibnite occurs in some of the gold-quartz veins at Cocoa Creek (Starcke No. 1 Goldfield), but attempts to recover the mineral were not successful.

John Dickie discovered an antimony deposit near Kimba Homestead, 30 km east of the Alice River Gold and Mineral Field, in 1907. Cherry (1907) described several antimony occurrences within 2.5 km of the main (Dickies No. 1 or Packsaddle 1) deposit. Old workings occur at some of the deposits but no production has been recorded.

4.1.6 Silica sand

The dunefields at Cape Flattery, north of Cooktown, were first described by Captain James Cook in 1770. Interest in the potential of the dunes as a source of silica sand was instigated by a Sydney-based consultant, F. Beggs, in 1964, after identifying potential Japanese markets. Cape Flattery Silica Mines Pty Ltd was formed and confirmed the presence of extensive deposits of high quality silica sand suitable for glass manufacturing and foundry sand. A bulk sample was sent to Japan; a contract was negotiated for the supply of 340 000 t of silica sand over three years; the company obtained a number of leases from F. Beggs; and mining commenced in 1968.

Mining was originally by dredging at Mount Mitchell. The sand was beneficiated on site, trucked to a wharf at Cape Flattery, and transported by barge to ships for export. In 1987, dry mining commenced at Airport Lake. Total recorded production from 1968 to June 1993 was 14.8 Mt. All production has been for export for the glass making and foundry industries.

4.1.7 Heavy minerals

In 1992, Saracen Minerals N.L. produced 293 t of ilmenite and 19 t of monazite as a by-product of gold mining at Oscar Creek, near Coen. These minerals were sold for use in sand blasting at Weipa.

4.1.8 Bauxite

The conspicuous red cliffs along the western coastline of Cape York Peninsula were first recorded by Matthew Flinders in 1802; references to laterites in the general area were made by R.L. Jack in 1880 and C.V. Jackson in 1902. The extent and economic potential of the bauxite deposits on the west coast of Cape York Peninsula were first recognised by H.J. Evans in 1955 while carrying out a regional reconnaissance for oil.

In 1957, the Queensland Government and Commonwealth Aluminium Corporation Pty Ltd signed an agreement (the Commonwealth Aluminium Corporation Pty Ltd Agreement Act of 1957) to allow the company to develop the deposits and construct the mining town of Weipa. Comalco Aluminium Ltd was formed in 1960 and the first commercial shipment of bauxite was made in 1963. In 1970, a bauxite calcination plant was commissioned; it is the only one of its kind in Australia.

Total bauxite production from 1960 to 1993 was 206 Mt of beneficiated and calcined bauxite. Mining has been carried out on ML 7024 (previously Special Bauxite Mining Lease No. 1).

4.1.9 Kaolin

Kaolin was found shortly after the discovery of the Weipa bauxite in 1955. In the early 1970's, samples of kaolin were tested for use as a refractory calcined clay, which could be produced in the bauxite calcination kilns at Weipa. Towards the end of the 1970's, it was recognised that the kaolin had potential for use in the paper industry as a filler and for coating. A processing plant was constructed and the first kaolin mined in 1985 (Schaap, 1990). The first shipment to Japan was made in 1987/88. Total recorded production from 1986 to 1993 was 583 481 t.

4.1.10 Mica

A small muscovite mine was worked near the headwaters of the Morehead River, 12.8 km west-southwest of Dixie Homestead, from 1941 to 1943. In 1942, a parcel of a few hundred kilograms was made up from 3.5 t of split mica and sent to Melbourne. The mine was closed by 1944.

4.1.11 Phosphate

Small guano deposits were reportedly worked on Raine Island, Booby Island and Bramble Cay, in Torres Strait, probably in about 1878.

4.2 Current mining activity

The total value of mineral production from the CYPLUS study area in 1992/93 was $262 316 587, which represents 4.7 % of the total mineral production of Queensland and 14.5 % of non-fuel minerals. This included all of Queensland's bauxite production and (by value) 98 % of kaolin, 84 % of silica, and 0.5 % of gold production. The CYPLUS area is the third most important non-fuel mineral producing area in Queensland after Mount Isa and Charters Towers.

4.2.1 Bauxite

The only producing bauxite mine in the area is Comalco Aluminium Ltd's operation at Weipa, which is the largest single bauxite mining and shipping centre in the world. The metal produced around the world from Weipa bauxite each year is worth more than $4 billion (White, 1991).

The company owns and operates a smelter at Bell Bay in Tasmania, and semi-fabricating facilities in Australia, New Zealand and the United States. It has consortium interests in bauxite mining in Guinea, West Africa, in alumina refineries at Gladstone and in Sardinia (Italy), and in aluminium smelters which it manages at Boyne Island in Queensland and Tiwai Point in New Zealand. It has been carrying out a joint study with Alcan on the feasibility of a new Queensland alumina refinery based on Weipa bauxite. The recent purchase of the Gladstone power station by Comalco will lead to an expansion of the Boyne Island smelter facilities.

Bauxite mining is carried out by Comalco at Weipa and in the Andoom area, 19 km north of Weipa. Approximately 70 % of all bauxite mined in the area comes from Andoom. It is a simple opencut operation. Scrapers remove the topsoil and front-end loaders pile the ore into 150 t bottom dump trailers. The ore is washed and sized at a beneficiation plant and then transported by ship to refineries in Australia and overseas. About 70% of the beneficiated bauxite is sent to the Queensland Alumina Refinery at Gladstone; the remainder is exported to Europe, USA, USSR and Japan. Future markets include Korea, where agreement has been reached to supply bauxite to a hydrate plant. The current bauxite product is obtained by blending Weipa and Andoom ore to give a composition of approximately 54.5% Al_2O_3 and 5.4% SiO_2. A low-iron variety is mined for production of calcined bauxite for synthetic corundum feed for the abrasives industry.

Total production in 1992/93 was 8 590 724 t of beneficiated bauxite ($197 670 085) and 179 494 t of calcined bauxite ($20 339 211). In its 1992 Annual Report, Comalco reported total bauxite reserves of 248 Mt and a total resource of 3700 Mt for its ML 7024 (formerly SBML 1).

4.2.2 Silica sand

The Cape Flattery Silica Mine is owned and operated by Cape Flattery Silica Mines Pty Ltd, a wholly owned subsidiary of Mitsubishi Trading Company. Sand is endloaded onto an advancing portable conveyor belt, beneficiated in a stationary central mill by washing and heavy mineral separation, and dewatered and stockpiled using a mobile stacker cyclone. A mobile reclaimer loads stockpiled sand onto a conveyor for transport to a new wharf on the southern part of Cape Flattery headland. The wharf is capable of handling Panamax vessels of up to 70 000 t capacity.

Cape Flattery Silica Mines Pty Ltd has proved reserves of 200 Mt under mining lease (Cooper, 1993d); the potential resource in the area would be much greater. Total production in 1992/93 was 1 801 048 t, valued at $21 317 096. All production is exported to Japan, Korea, Taiwan and the Phillipines for glass manufacture (60 %), foundry purposes (30 %) and the chemical industry (10 %).

4.2.3 Kaolin

Kaolin is mined by Comalco Aluminium Ltd at Weipa. Total production in 1992/93 was 131 614 t of kaolin valued at $20 726 799.

The kaolin occurs in the pallid zone of the laterite profile and is mined from areas after the overlying bauxite has been removed. The deposits are discontinuous clay lenses approximately 2 to 3 km long, 300 m wide and 4.5 m in average thickness.

The processing plant accepts the material as a slurry from a classification plant near the mine stockpile. After electromagnetic separation of iron impurities, a kaolin cake is produced by extraction of the residual water. This cake is dried to coarse kaolin beads by blasts of hot air. The beads are then exported, mainly to Japan.

The deposit has proved and probable reserves of 17.8 Mt, with a further 5.7 Mt of possible ore available. Total resources may be as high as 50 Mt (Cooper, 1993c).

4.2.4 Gold

There are no large gold mines or prospects in the study area, but numerous small alluvial operations are current. Total production of gold bullion (alluvial and lode) in 1992/93 was 155 kg valued at $2 223 934.

Small to medium-scale alluvial gold mining is being carried out along the Palmer River and its tributaries from the Strathleven area upstream to the headwaters of the Palmer and South Palmer Rivers.

As well as alluvial mining, underground mining of auriferous quartz veins is being carried out in the West Normanby River area.

Small-scale gold mining is also carried out in the old Starcke Nos 1 and 2 Goldfields, Ebagoola Goldfield and Coen Goldfield.

4.2.5 Building stone

A number of small-scale slate quarries or pits have been developed between the St George and Palmer Rivers on Maitland Downs Station. Most of these quarries are worked intermittently due to poor access in the wet season. The larger operators include Mr R.D. Joseph, River of Gold Slate Company, Rogina Stone and Slate, and Palmer River Slate. The slate has a phyllitic sheen and is brown to dark grey; yellow to red colouration is common in the more highly weathered surface deposits. The stone is marketed in the Cairns area as random and crazy pavers and for landscaping (Trezise, 1990). High overheads associated with remote location and generally lower quality stone reduce its competitiveness with many cheaper imported slates. Total production in 1992/93 was 55 t of slate valued at $39 462.

4.2.6 Tin

The study area has been an important producer of tin and contains a number of significant tin deposits. The main impediment to development of these deposits is the continuing depressed state of the tin market. Total production in 1991/92 was 0.106 t valued at $465. No tin concentrates were produced in 1992/93.

Small-scale mining is still carried out intermittently at Mount Poverty and at Nolan Creek near Rossville.

4.3 Recent exploration

The results of company exploration in the CYPLUS area have been described in detail by Culpeper and others (1992a) and are given in the mineral occurrence reports for individual Sheet areas. Denaro and Shield (1993) have summarised the results of coal and petroleum exploration.

Prior to 1969, company exploration focused mainly on heavy minerals along the coastline, alluvial gold and heavy minerals in the drainage systems, bauxite on the west coast, and silica sand in the Cape Flattery area. In the early 1970's, investigation of the bauxite deposits continued. Exploration was also carried out for base metal deposits in the southern Coen Inlier and for alluvial gold and tin. Much of the exploration of the late 1970's was for gold, uranium and base metal deposits in the Proterozoic inliers, although the search for alluvial tin, gold and heavy mineral deposits continued.

In the early 1980's, exploration was directed towards alluvial and lode deposits of gold and tin. In the late 1980's, almost all exploration was for gold; some exploration was for heavy minerals (for their rare earth elements content), silica sand at Cape Flattery and Shelburne Bay, and kaolin on the west coast.

Recently, exploration focused on the base metal potential of the Coen and Yambo Inliers. Exploration has also been carried out for hard rock gold deposits in the Coen and Ebagoola Goldfields, for alluvial gold in the Palmer Goldfield, and for heavy minerals at Colmer Point.

Company exploration has led directly to the delineation of bauxite deposits on the west coast, silica sand at Cape Flattery and Shelburne Bay, kaolin deposits at Weipa and Skardon River, coking coal at Bathurst Range, heavy minerals at Colmer Point, alluvial tin resources at Granite Creek (north of Coen), lode tin deposits at Jeannie River and Collingwood, copper at the Dianne Copper Mine, tungsten at Spring Creek, and numerous small alluvial gold, tin and heavy mineral resources.

5.0 GEOLOGY AND MINERALISATION

5.1 Regional geology

Cape York Peninsula consists of a stable shield of Proterozoic metamorphic and Palaeozoic granitic rocks (the Coen and Yambo Inliers) overlain by gently dipping Mesozoic and Cainozoic sedimentary rocks of the Carpentaria, Laura and Karumba Basins (Figure 4).

The Coen and Yambo Inliers are separated from folded Palaeozoic sediments of the Hodgkinson Province by the Palmerville Fault. The Coen Inlier and Hodgkinson Province have been intruded by late Palaeozoic granitic rocks with associated acid volcanics.

Late Palaeozoic granitic and acid volcanic rocks form the Cape York - Oriomo Inlier, which extends from Cape York across Torres Strait to Papua New Guinea.

The predominant structural trend in Cape York Peninsula is northerly. The inliers, igneous belts and sedimentary basins are all elongated in this direction.

5.1.1 Geological history

The oldest exposed rocks in the study area are the metamorphic rocks of the Coen and Yambo Inliers. These rocks formed from mudstone, sandstone, basic volcanics and limestone deposited in a shallow water, relatively stable (shelf) environment in the Proterozoic (probably <1500 million years ago) (Ewers & Bain, 1992). During or after deposition of the sediments, mafic to intermediate sills (greenstone) were intruded into parts of the sedimentary sequence. Subsequent deformation and metamorphism resulted in the closure of the basin, and the formation of indurated sandstone and siltstone, slate, phyllite, schist, amphibolite, gneiss, iron-formation and marble of the Coen, Sefton, Holroyd and Dargalong Metamorphics and the Newberry and Edward River Metamorphic Groups. Iron-formation rocks host iron, manganese and gold mineralisation. Small, stratabound base metal sulphide deposits occur in the metamorphic rocks.

About 400 million years ago, during the peak of a second major metamorphic event, the Proterozoic rocks were extensively intruded by the granitic rocks of the Cape York Peninsula Batholith over a distance of at least 420 km, from the Yambo Inlier in the south to Weymouth Bay in the north. These granites were emplaced at relatively deep levels in the earth's crust and the surrounding rocks were regionally metamorphosed and, in places, hydrothermally altered and partially melted (migmatised). Granite emplacement was accompanied by regional shearing and the emplacement of gold-bearing quartz veins (Ewers & Bain, 1992). The granites have been subdivided geochemically into the I-type Flyspeck and Blue Mountains Supersuites and the S-type Kintore Supersuite.

Sedimentation in the Hodgkinson Basin, on the eastern side of the Yambo Inlier, commenced in the Ordovician (~500 to 440 million years ago), centred on pre-existing weaknesses in the Proterozoic crust. A backarc setting in a marginal sea related to subduction has been postulated (Bultitude & others, 1993) for the Hodgkinson Basin. Volcanism with accompanying quartzose flysch sedimentation ceased at the beginning of the Silurian, probably due to "stepping" of the subduction zone farther to the east.

Figure 4

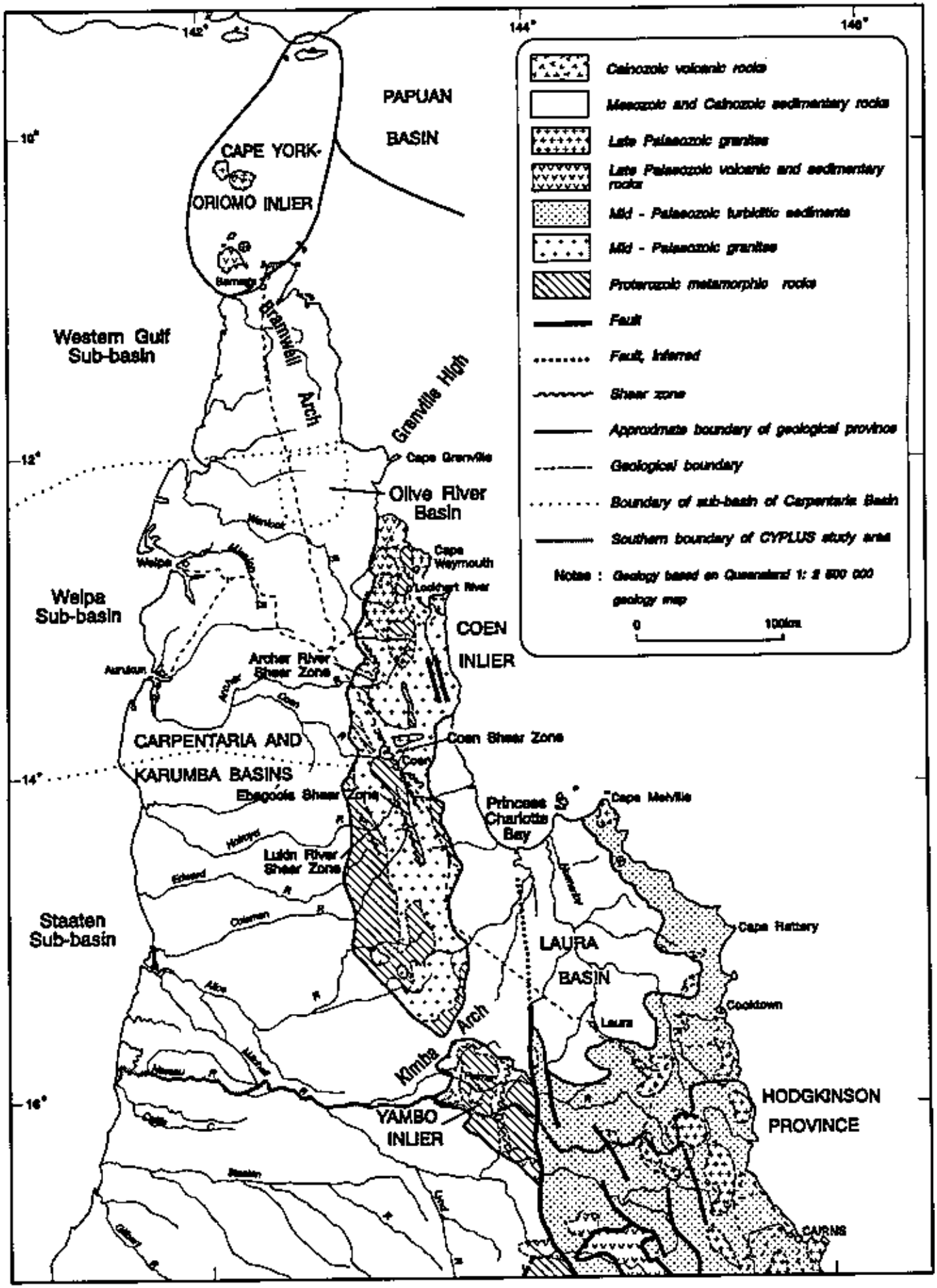

Figure 4: Regional Geology

In the Early Silurian (~420 million years ago), the Palmerville Fault system formed a hinge zone between the exposed Proterozoic craton and a subsiding depositional area to the east. Siliciclastic and carbonate sediments of the Chillagoe Formation were deposited in a relatively stable, shallow marine rift basin close to the fault (Bultitude & others, 1993). Sedimentation was accompanied by voluminous eruptions of mafic lava, and fossiliferous limestones formed on volcanic highs (Arnold & Fawckner, 1980). Base metal deposits with volcanogenic affinities are locally associated with the sediments and intercalated mafic volcanics.

The rate of subsidence increased markedly in the Early to Middle Devonian (~410 to 375 million years ago). The stable Chillagoe Formation basin evolved into a large, deep marine basin, and a very thick sequence of predominantly turbidity-current deposits (Hodgkinson Formation) accumulated. This deposition is thought to have occurred in an environment of crustal extension behind an active subduction zone at the rifted margin of the craton, far to the east (Bultitude & Donchak, 1992). The Hodgkinson Formation consists mainly of greywacke with minor interlayered chert and basalt, as well as a few small limestone lenses. The uplifted Proterozoic western margin was the major source of the siliciclastic sediments. Flysch-type deposition continued into at least the Late Devonian (~375 to 360 million years ago).

In the Early Carboniferous (~360 to 325 million years ago), freshwater sediments were deposited in small basins in the northern part of the Coen Inlier (Pascoe River beds) and farther north in the Olive River Basin. These sediments comprise sandstone, arkose, greywacke, siltstone and shale, with some coal, conglomerate and chert.

In the Late Devonian or Early Carboniferous, sedimentation in the south ceased when eastward-directed thrusting closed the Hodgkinson Basin. The Hodgkinson Basin succession was strongly folded and faulted. The tectonism resulted in the imbrication of the succession into numerous westward-younging thrust slices (Donchak & others, 1992). The region gradually emerged above sea level, most probably in the Early Carboniferous. Gold-bearing quartz veins formed during metamorphism and dewatering of the sediment pile.

The Proterozoic and early to mid-Palaeozoic rocks were eroded in the Late Carboniferous to Permian and the landscape became subdued. Sediments were deposited in lakes and in shallow, fault-bounded marine rift basins formed by regional crustal extension. Acid volcanism occurred in places. Coal occurs in the sediments of the Litle River Formation, Normanby Formation and the Olive River Basin.

In the Late Carboniferous to Early Permian (~300 to 270 million years ago), post-orogenic, high-level I-type granitic batholiths were emplaced in the north of the Coen Inlier and in the Cape York - Oriomo Inlier. Co-magmatic volcanic rocks were erupted near Iron Range, Cape Grenville and in Torres Strait (Willmott & others, 1973). Minor volcanic activity also occurred in the far east of the Hodgkinson Province, south of Cooktown (Donchak & others, 1992). These volcanics are mainly rhyolitic to dacitic flows and tuffs. The emplacement of the granites and volcanics was accompanied by localised gold, tin and tungsten mineralisation.

Extensive granite emplacement also occurred in the eastern part of the Hodgkinson Province in the Early to Late Permian (~290 to 250 million years ago). Both I-type and S-type granites were intruded. Early Permian andesitic to rhyolitic volcanics (Normanby

Formation) are also present in the Cooktown area. Most of the granites are high-level types and are cut by acid and rare basic dykes. They are associated with tin and tungsten mineralisation.

In the Late Permian to Early Triassic (about 250 million years ago), a widespread, major deformational event characterised by the development of extensive shear zones affected rocks in the coastal zone of the Hodgkinson Province. This shearing post-dated the granites (Donchak & others, 1992).

In the Middle to Late Jurassic (~185 to 140 million years ago), fluviatile quartzose sand was deposited in structurally controlled erosion depressions on an erosion surface of mainly deformed Proterozoic rocks, west of the Coen and Yambo Inliers. This was the start of deposition of the sediments of the Carpentaria Basin. The region was covered by a blanket of continental and marine sands (Gilbert River Formation) in the Late Jurassic to Early Cretaceous. Shallow marine sediments of the Helby beds accumulated in the north.

In the Middle Jurassic to Early Cretaceous, much of the previously uplifted Hodgkinson Province (and Yambo Inlier) sagged, especially adjacent to the Palmerville Fault, to form a depression in which the fluviatile-lacustrine to shallow marine sediments of the Laura Basin were deposited (Bultitude and Donchak, 1992).

Sedimentation continued in the Early Cretaceous (~140 to 95 million years ago), when a very large, shallow, epicontinental sea covered both basins. The Jurassic sediments contain coal measures and the sedimentary sequences are an important source of groundwater in Cape York Peninsula.

Following emergence at the end of the Cretaceous (~65 million years ago), the Mesozoic sediments were partly eroded and older rocks exposed in the Tertiary (~65 to 1.65 million years ago). Uplift in the east raised the basement rocks in the centre of the Peninsula to their present elevation. Uplift occurred in stages and fluviatile sand, gravel and clay deposits were deposited in broad downwarps in the Laura Basin. Broad downwarping of the Carpentaria Basin formed a new, shallow basin (the Karumba Basin) in which fluviatile sand, gravel and clay were deposited (Bultitude & others, 1993).

The sediments of the Karumba Basin reflect several cycles of uplift, erosion and deposition, each followed by deep weathering of the stabilised land surfaces (Grimes, 1980). The bauxite deposits of the Weipa Peninsula formed during these deep weathering events.

Uplift of the Hodgkinson and Laura Basins was accompanied by faulting and localised basaltic volcanism. Numerous volcanic vents have been recognised in the Cooktown - Lakeland Downs - McIvor River area. The basalt flows and pyroclastics of the McIvor River Basalt Province, Piebald Basalt Province and McLean Basalt were erupted in the Miocene to Pleistocene (~6 to 1 million years ago).

Erosion and deposition in the Quaternary (1.65 million years ago to present) led to the formation of alluvial deposits along the major river systems, estuarine and deltaic deposits at the mouths of the major rivers, and the formation of beach ridges and sand dunes along the shoreline. These sediments are sources of alluvial gold, tin and heavy minerals. The sand dunes are a source of silica sand.

5.2 Known mineralisation and resources

Figure 5 shows the location of mineral deposits in the CYPLUS area which have known production or resources. Production and resource figures are given in Table 3.

5.2.1 Gold

Within the study area, gold deposits fall into a number of broad categories.

1) Proterozoic, metamorphosed stratabound/stratiform deposits occur in the Coen Inlier. Both syngenetic and epigenetic mineralisation occur.

2) Mesothermal, shear zone-hosted gold-quartz vein mineralisation may be related to the intrusion of the Silurian to Devonian granites of the Cape York Peninsula Batholith and/or to associated metamorphism.

3) Gold mineralisation occurs associated with chert/quartzite lenses in the Hodgkinson Formation.

4) Breccia, vein and stockwork deposits are related to Carboniferous to Permian granites and subvolcanic complexes with dykes, plugs, stocks and breccias of rhyolitic to trachytic composition.

5) Mesothermal, syntectonic "slate belt" type gold-quartz veins in the Hodgkinson Province are also of Carboniferous to Permian age.

6) Gold occurs in quartz veins of possible epithermal affinity in late Palaeozoic volcanic-sedimentary units.

7) Mesozoic and Tertiary palaeochannel (deep lead) and Recent alluvial and eluvial placer gold deposits.

The general distribution of the deposit types is shown on Figure 6.

Figure 5

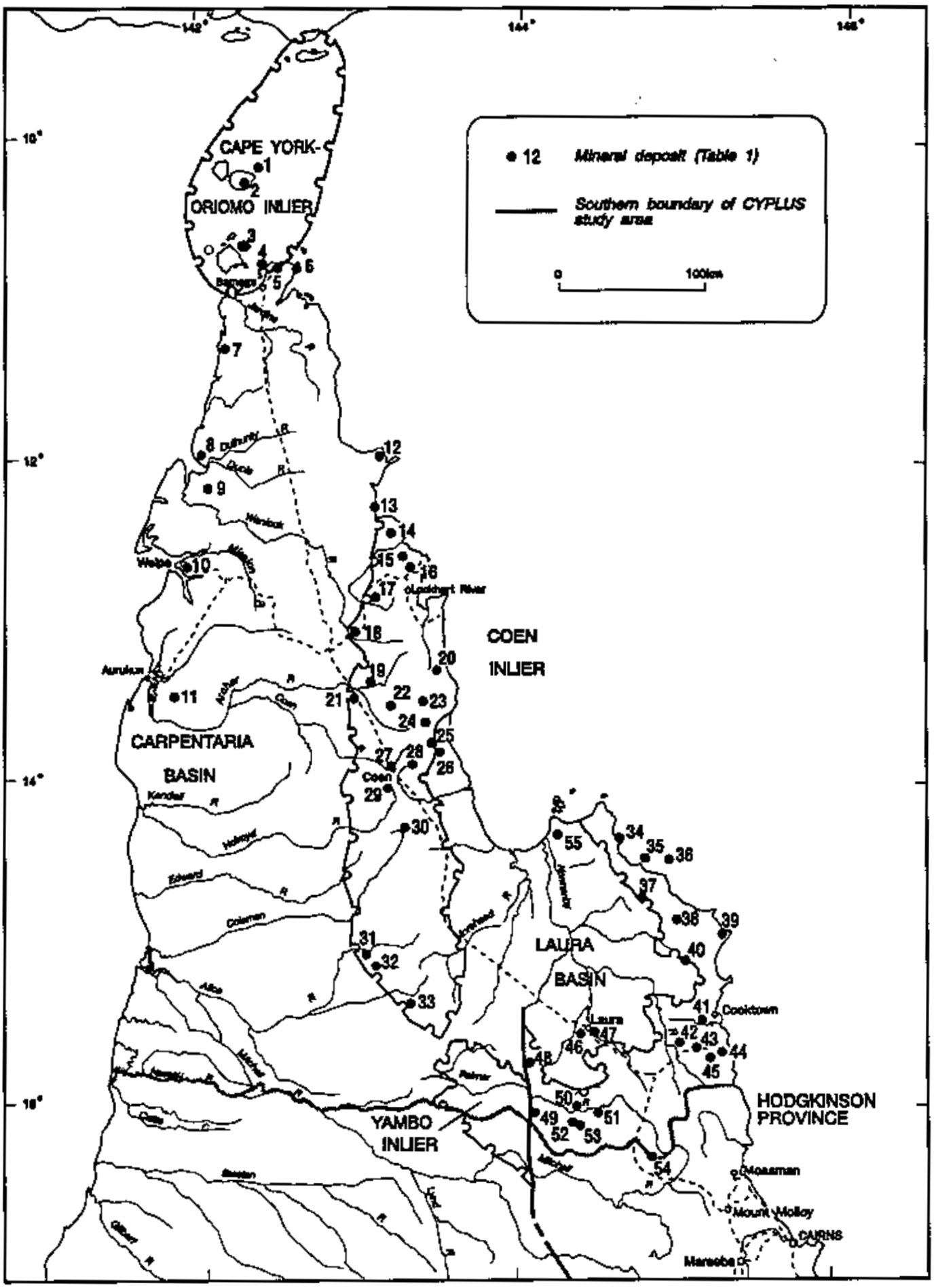

Figure 5: Distribution of mineral deposits with known production or resources

Table 3: Mineral deposits with known production or resources

Deposit number	Name	Type and age of deposit	Recorded production and years of main production	Resources and reserves
1	Portlock Island	Quartz lodes in Carboniferous acid volcanics and related porphyritic granite	30 kg wolframite, 1951	
2	Noa Island	Quartz lodes in Carboniferous acid volcanics and related porphyritic granite	About 101 t wolframite, 1938-1956	
3	Horn Island Goldfield	Au-base metal sulphide-quartz veins and stockworks in Carboniferous acid volcanics and related porphyritic granite; alluvial placer	About 1643 kg of gold bullion, 1894-1909, 1935, 1988-1989	Inferred resource: 2.35 Mt @ 2.37 ppm Au
4	Possession Island Goldfield	Au-base metal sulphide-quartz veins and stockworks in Carboniferous acid volcanics and related porphyritic granite; alluvial placer	About 113 kg of gold bullion, 1897-1919	
5	Cape York Tinfield	Quartz veins and sheeted quartz veins in Carboniferous acid volcanics and associated intrusive porphyries; alluvial stream and beach placers	About 37 t cassiterite, 1950-1986	Northern Mine: 200 t @ 7.2 % recoverable Sn. Fourteen Acre Mine: 1000 t @ 0.7 % recoverable Sn. Booty and Maula Creeks: 448 000 m^3 of alluvium @ 310 g/m^3 cassiterite. Lady Luck lease: 660 000 m^3 of beach sands @ 193 g/m^3 cassiterite.
6	Turtle Head Island-Escape River	Lateritic bauxite developed on Cretaceous to Tertiary sediments; Quaternary sand dunes		230 Mt bauxite; >30 Mt silica sand
7	Vrilya Point	Lateritic bauxite developed on Cretaceous to Tertiary sediments		100 Mt bauxite @ 44 to 45 % total Al_2O_3 and 7 % reactive silica
8	Skardon River	Kaolin in pallid zone of lateritic profile developed on Cretaceous to Tertiary sediments		27 Mt kaolin; silica resources confidential
9	Alcan South Pacific Ltd lease (ML 7031)	Lateritic bauxite developed on Cretaceous to Tertiary sediments		75 Mt bauxite
10	Weipa Bauxite Mine	Lateritic bauxite developed on Cretaceous to Tertiary sediments; kaolin in pallid zone of laterite profile	206 Mt bauxite, 583 481 t kaolin, 1960-1993	Resource: 3 700 Mt bauxite, 50 Mt kaolin. Reserves: 248 Mt bauxite, 17.8 Mt kaolin.

Deposit number	Name	Type and age of deposit	Recorded production and years of main production	Resources and reserves
11	Aluminium Pechiney Holdings Pty Ltd lease (ML 7032)	Lateritic bauxite developed on Cretaceous to Tertiary sediments		300 Mt bauxite
12	Shelburne Bay	Silica sand dunes		Resources: 143 Mt silica sand Reserves: 40 Mt silica sand
13	Bolt Head	Limestone in Proterozoic metamorphic rocks		25 000 t
14	Tin Creek and First Stony Point Tinfields	Alluvial placers	About 14 t cassiterite, 1900-1940	
15	Iron Range	Metamorphosed, stratabound/stratiform iron-manganese deposits in Proterozoic metamorphic rocks		1.0 Mt @ 54 to 62 % iron and manganese, 300 000 t @ 45 to 55 % combined iron and manganese
16	Claudie River Gold and Mineral Field	Stratabound Au-Fe-Mn deposits and associated quartz veins in Proterozoic metamorphic rocks; quartz veins in Permian granite; alluvial placers	About 333 kg of gold bullion, 1934-1942	
17	Bowden Mineral Field	Quartz veins in Proterozoic metamorphic rocks and related to Permian granite	About 71 t wolframite, 1904-1916, 1952	
18	Wenlock Goldfield	Quartz reefs in shear zones in Silurian-Devonian granites and along granite-metamorphic contact; quartz veins in Permian granite; alluvial placers (including deep leads at base of Mesozoic sequence)	About 1528 kg of gold bullion, 1892-1951, 1964-1978	
19	Granite Creek (near Coen)	Alluvial placers	About 334 t cassiterite, 1907-1940, 1977-1978	4.1 Mm^3 of alluvium @ 1.13 kg/m^3 cassiterite
20	Hayes Creek Goldfield	Quartz reefs in shear zones in Silurian-Devonian granite; alluvial placers	About 29 kg of gold bullion, 1909-1914, 1834-1953	5 000 m^3 alluvial wash @ up to 0.33 g/m^3 Au
21	Battery lease	Quartz reefs in shear zones in Proterozoic metamorphic rocks, close to the contact with Silurian-Devonian granite	About 6.8 kg of gold bullion, 1903-1913	
22	Blue Mountains	Quartz reefs in shear zones in Silurian-Devonian I-type granite; alluvial placers	About 52 kg of gold bullion, 1934-1951	
23	Nullimbidgee	Quartz reefs in shear zones in Silurian-Devonian granite; alluvial placers	About 2.2 kg of gold bullion, 1952-1957	

Deposit number	Name	Type and age of deposit	Recorded production and years of main production	Resources and reserves
24	Leo Creek	Quartz reefs in shear zones in Silurian-Devonian granites and along granite-metamorphic contact; alluvial placers	About 88 kg of gold bullion, 1896-1910	
25	Rocky River Goldfield	Quartz reefs in shear zones in Silurian-Devonian granites and along granite-metamorphic contact; alluvial placers	About 39 kg of gold bullion, 1893-1896	
26	Colmer Point	Sand dunes (palaeo-beach ridge deposits)		192 Mt silica; heavy mineral resources confidential
27	Coen Goldfield	Quartz reefs in shear zones in Proterozoic metamorphic rocks and Silurian-Devonian granites and along granite-metamorphic contact; gold associated with Carboniferous-Permian porphyritic rhyolite dykes; alluvial placers	About 3564 kg of gold bullion, 1876-1918, 1952	
28	Grand Final	Quartz vein in a Silurian-Devonian granite	5.8 t wolframite and 130 kg molybdenite, 1904-1918, 1952	
29	Lochinvar Provisional Goldfield	Quartz reefs in shear zones in Silurian-Devonian granite; alluvial placers	About 2.2 kg of gold bullion, 1904	
30	Hamilton Goldfield	Quartz reefs in shear zones in Proterozoic metamorphic rocks and Silurian-Devonian granites and along granite-metamorphic contact; gold associated with Carboniferous-Permian porphyritic dykes, breccia and intrusions; alluvial placers	About 2292 kg of gold bullion, 1900-1951	
31	Potaitah Creek Goldfield	Quartz reefs in shear zones in Proterozoic metamorphic rocks, close to the contact with Silurian-Devonian granite; alluvial placers	About 22 kg of gold bullion, 1902-1914, 1942-1947	
32	Gossan Prospect	Stratiform polymetallic massive sulphide in black shale and basic igneous rocks of a Proterozoic metamorphic formation		50 000 t @ 10 % combined Cu, Pb and Zn sulphides
33	Alice River Goldfield	Quartz reefs in shear zones in Silurian-Devonian granite; alluvial placers	About 115 kg of gold bullion, 1903-1916, 1936	

Deposit number	Name	Type and age of deposit	Recorded production and years of main production	Resources and reserves
34	Barrow Point	Alluvial placer	0.25 t cassiterite, 1939	
35	Noble Island	Quartz vein stockwork in Devonian metasediments and related to Permian granite	About 19 t wolframite, 1904-1916	
36	Howick Island	Quartz veins in Permian granite; alluvial placer	0.5 t cassiterite and 250 kg wolframite, 1921	
37	Jeannie River Prospect	Complex tin-sulphide lodes in Devonian metasediments intruded by Permian granite		6.7 Mt @ 0.8 % Sn
38	Starcke No. 2 Goldfield	Syntectonic/symmetamorphic Au-quartz and Au-Sb-quartz veins in Devonian metasediments; alluvial placers	About 434 kg of gold bullion, 9 t of 9 % Sb ore, 1890-1913	
39	Cape Flattery Silica Mine	Silica sand dunes	14.8 Mt silica sand, 1968-1993	Reserves: 200 Mt silica sand
40	Starcke No. 1 Goldfield	Syntectonic/symmetamorphic Au-quartz and Au-Sb-quartz veins in Devonian metasediments; alluvial placers	About 35 kg of gold bullion, 1892-1896	
41	Six Mile Creek	?Epithermal quartz veins in Permian intermediate volcanics and sediments	About 2.7 kg of gold bullion, 7 t of 58 % Sb ore, 1921, 1939-1948	
42	Melody Rocks	Limestone in Devonian metasedimentary sequence		>100 Mt of high to chemical grade limestone
43	Kings Plains Prospect	Alluvial placer		87 Mm^3 of alluvium @ 130 g/m^3 cassiterite, 77 g/m^3 cutoff (including 42 Mm^3 @ 160 g/m^3 cassiterite)
44	Collingwood Tin Prospect	Cassiterite in siliceous sheeted veins, albitic veins and greisen associated with Permian granite		3 106 980 t @ 0.90 % Sn (including 2 027 609 t @ 1.00 % Sn)

Deposit number	Name	Type and age of deposit	Recorded production and years of main production	Resources and reserves
45	Cooktown Tinfield	Quartz-tourmaline lodes and sheeted veins, greisen veins, and greisen and argillic alteration zones in Permian granites; alluvial placers	About 12850 t cassiterite, 8.3 t wolframite, 1885-1992	Sandhills Prospect: 14 963 loose m^3 of greisen @ 0.74 kg/m^3 cassiterite and 28 416 loose m^3 @ 0.66 kg/m^3 cassiterite. Lee Creek: 2.1 Mm^3 of alluvium @ 383 g/m^3 cassiterite (0.9 Mm^3 of wash @ 759 g/m^3 cassiterite). Mungumby Creek: 595 125 m^3 of alluvium @ 0.20 kg/m^3 cassiterite (434 760 m^3 @ 0.43 kg/m^3 cassiterite). Mount Hartley Creek: 381 440 m^3 of alluvium @ 0.18 kg/m^3 cassiterite. Grasstree Pocket: 1 Mt of slopewash and colluvium @ 138 g/t cassiterite. Just In Time claim: 96 449 m^3 of eluvium @ 0.55 kg/m^3 cassiterite, 0.2 kg/m^3 cutoff.
46	Mosman River	Alluvial placer		232 000 m^3 of alluvium @ 0.19 g/m^3 Au(+Pt+Pd), 0.1 g/m^3 cutoff
47	Laura River	Alluvial placer		1.3 Mm^3 of alluvium @ 4.2 ppm Au(+Pt+Pd)
48	St George Copper Mines	Secondary copper and mercury mineralisation in shears in Devonian basic volcanic rocks	5 t of 24 % Cu ore, 1905-1907	
49	Mitchell-Palmer Rivers	Limestone in Silurian-Devonian metasedimentary sequence		~1 500 Mt limestone
50	Palmer Goldfield (including the West Normanby Goldfield)	Syntectonic/symmetamorphic Au-quartz and Au-Sb-quartz veins in Devonian metasediments; gold-bearing chert-quartzite units; alluvial placers (including deep leads at base of Mesozoic sequence)	About 37551 kg of gold bullion, 1874-1990	Fernhill Bend: 1 653 000 m^3 of alluvium @ 337 mg/m^3 Au. Palmerville crossing: 1 119 000 m^3 of alluvium @ 395 mg/m^3 Au. Glenroy Creek-Palmer River: 35 000 m^3 of alluvium @ 255 mg/m^3 Au. West Normanby River: 596 000 m^3 of alluvium @ 0.4 g/m^3 Au + 470 000 m^3 @ 0.2 g/m^3 Au. West Normanby River-Granite Normanby River junction: 600 000 m^3 of alluvium @ 0.26 g/m^3 Au.
51	Dianne Copper Mine	Volcanic-associated massive sulphides in Devonian metasediments	69 820 t of ore (>18 000 t Cu and 1000 kg Ag), 1980-1983	20 000 t unrecovered oxidised ore

Deposit number	Name	Type and age of deposit	Recorded production and years of main production	Resources and reserves
52	Cannibal and Granite Creeks	Quartz-greisen lodes in Devonian metasediments and Permian granite; alluvial placers	About 2843 t cassiterite, 1880-1970	
53	Spring Creek	Quartz-greisen veins in tourmalinised Devonian metasediments above a subsurface Permian granite	About 5967 t scheelite and 0.2 t wolframite, 1907, 1969-1970	
54	Watershed Prospect	Quartz veins and disseminated scheelite in Devonian calc-silicate rocks and Permian granite		14 Mt @ 0.3 % WO_3
55	Bathurst Range	Jurassic coking coal		157 Mt of medium to low volatile, bituminous coking coal with a moderately high sulphur content.

Figure 6

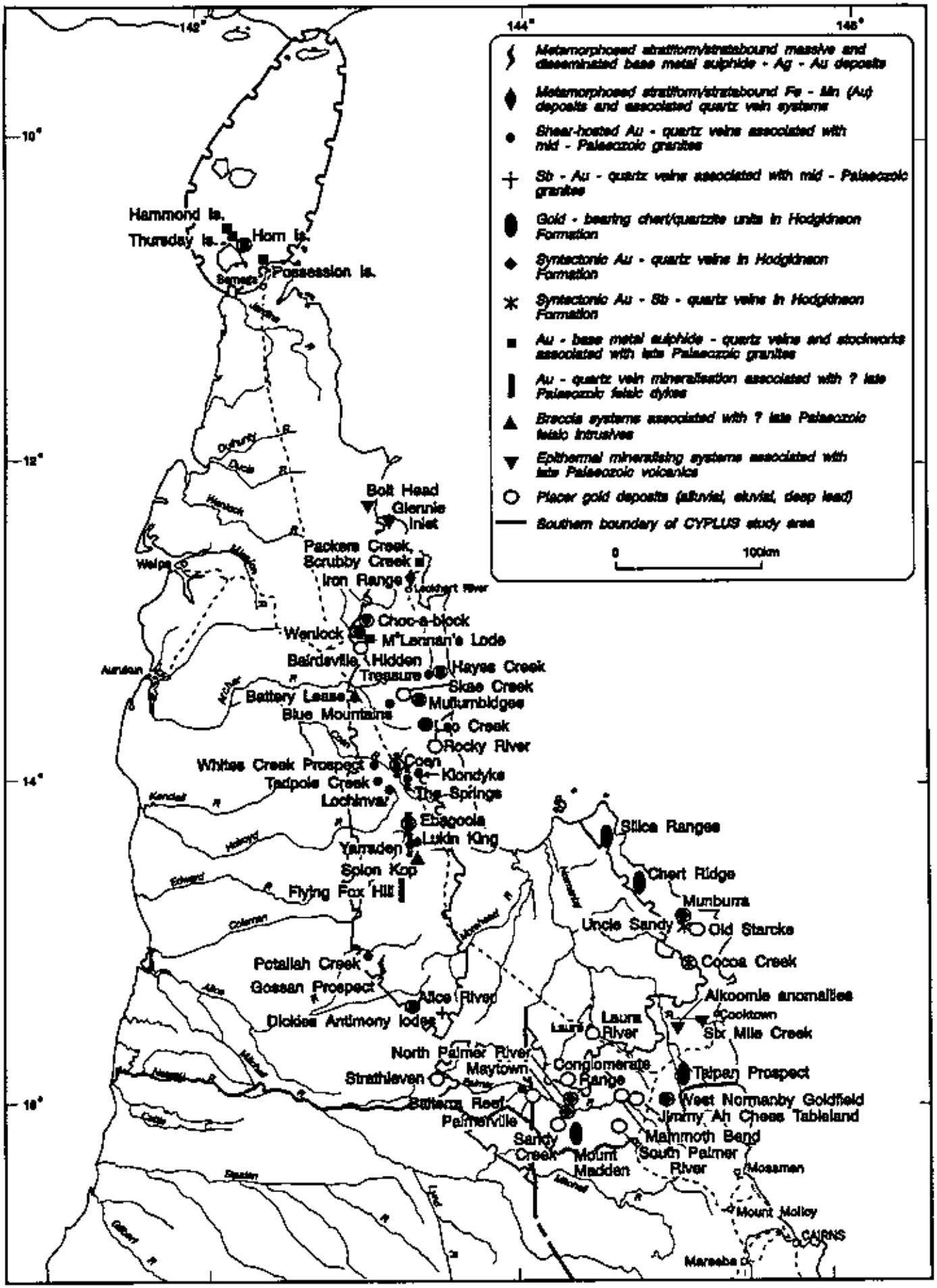

Figure 6: Distribution of gold and antimony deposits

5.2.1.1 Cape York - Oriomo Inlier. **Gold-base metal sulphide-quartz veins and stockworks** occur in welded tuff and porphyritic granite on Horn, Possession, Hammond and Thursday Islands in the southern Torres Strait area. The main focus of exploration has been the Horn Island Goldfield, where Torres Strait Gold Pty Ltd delineated indicated and inferred resources of 2.35 Mt at an average grade of 2.37 ppm Au in the 1980's (Levy & Storey, 1990).

The gold is restricted to quartz-carbonate reefs in altered porphyritic granite and microgranite; very little gold occurs in unveined granite. The main alteration products are green sericite, chlorite and illite occurring in narrow zones around veins and as more pervasive zones enclosing stockworks.

Sulphide minerals include pyrite, galena, sphalerite, chalcopyrite and arsenopyrite, and commonly form up to 20 % of ore shoots. Individual veins range from 0.3 to 10 m wide. The veins are tensional features, with well-developed comb quartz, laminated quartz and breccia textures. Much of the silica is cryptocrystalline and fluorite occurs in some veins. Gold is free in the oxidised zone, but closely associated with galena in the primary ore. These deposits fall into the porphyry-related vein and stockworks category of Morrison (1988).

Elsewhere on Horn Island, and on Possession Island, gold occurs in quartz-base metal sulphide veins in silicified, brecciated and sericitised volcanic rocks of the Torres Strait Volcanics.

5.2.1.2 Coen Inlier. **Metamorphosed stratabound/stratiform massive and disseminated base metal sulphide-silver-gold deposits** occur in the Proterozoic Holroyd Metamorphics in the Potallah Creek area. They have been investigated mainly as potential base metal resources, but drilling has indicated that the Gossan Prospect grades 19.7 to 94 ppm Ag and 0.2 to 0.6 ppm Au.

In the Iron Range area, gold mineralisation occurs as two distinct styles (**metamorphosed stratabound/stratiform gold-iron-manganese deposits** and **associated vein systems**)in banded iron formation of the Sefton Metamorphics. At the Northern Queen, A.I.F. and Peninsula Hope deposits, higher grade gold (> 10 ppm) is associated with quartz-sulphide veins and siliceous, silicate-pyrite-rich rocks of a banded iron formation which comprises mixed silicate, silica, sulphide, oxide and carbonate facies. Elsewhere in this area, the banded iron formation contains traces of gold (0.2 to 2.0 ppm).

At the Johnstons, Gordons and Ironclad deposits, epigenetic quartz-sulphide veins and stockworks occur proximal to the contact of banded iron formation and schist. They may have formed by structural remobilisation of stratabound mineralisation along a high angle overthrust.

Most of the gold production from the Coen Inlier has come from **gold-quartz veins in and adjacent to regional shear zones** which extend for tens of kilometres in Silurian to Devonian granites and adjacent Proterozoic metamorphic rocks. Bain and others (1990) considered that the mineralisation is probably related to the emplacement of Silurian to Devonian I-type granites. However, it should be noted that mineralisation occurs in both S- and I-types and that the S-types are considered to be later than the I-types (MacKenzie & Knutson, 1992). Therefore, the gold mineralisation is more likely to be related to mid-Palaeozoic deformation or to late Palaeozoic I-type magmatism.

Miezitis and Bain (1991) described the mineralisation as mesothermal quartz veins of the Charters Towers type (plutonic vein category of Morrison [1988]). However, Morrison (1988) considered the veins of the Coen and Hamilton goldfields to be related to Carboniferous porphyries rather than the Silurian to Devonian granites. On the basis of mineralisation characteristics (particularly sulphide mineralisation), these deposits have been classified as mesothermal quartz veins in this report. However, it is possible that the mineralisation is late Palaeozoic in age.

Within the study area, this style of mineralisation occurs in the Alice River, Potallah Creek, Ebagoola, Lukin King, Yarraden, Springs, Lochinvar, Coen, Klondyke, Leo Creek, Blue Mountains, Hayes Creek, Wenlock and Mullumbidgee areas. Mineralisation at Blue Mountains may be a special type related specifically to the I-type Blue Mountains Granite. In the Yarraden to Coen area, some gold remobilisation may have been associated with emplacement of ?late Palaeozoic rhyolite dykes within the regional shear zones.

The deposits occur as simple or compound quartz reefs in fissures and as lenticular, en-echelon and anastomosing quartz bodies along shears. Individual reefs are up to 2 m wide, several hundred metres long and steeply dipping. Massive euhedral and comb quartz is cut by veinlets and infilled with later generations of vugh-forming quartz. Wall rock alteration comprises sericite±carbonate±pyrite±chlorite selvedges up to 2 or 3 times the vein width and is most prominent in the granites. Brecciation and silicification are characteristic of the major producing mine - the Great Northern, at Coen. Some reefs have graphitic selvedges adjacent to ore shoots.

Mineralisation comprises a simple pyrite±arsenopyrite±base metal sulphide assemblage. Free gold generally occurs adjacent to sulphides; the gold has a gold:silver ratio of approximately 3:1. Mineralisation is generally restricted to short, rich shoots containing crosscutting generations of quartz and rarely occurs in primary quartz or wall rocks. Economic ore shoots tend to occur at inflection points along the shear zones. The best grades are in narrow leaders on the footwall and/or hanging wall. Veins mined in the past were very high grade (up to 300 g/t and generally 30 to 60 g/t). Stockwork and spur vein systems adjacent to the reefs are not well developed and generally grade up to 8 g/t Au. Altered granite generally assays <2.5 g/t Au. No opencut resources have been proven yet, despite extensive exploration in the Coen and Ebagoola areas. Remaining underground resources at known mines are probably limited and would support small-scale mining operations only.

The veins probably formed from hydrothermal fluids during brittle reactivation of faults and mylonite zones. The ore fluids were possibly of magmatic derivation, originating from deep crustal levels. Graphitic wall rock zones may have controlled deposition of gold in some of the ore shoots.

Porphyritic rhyolite and rhyodacite dykes of probable Carboniferous to Permian age are common in the area from Yarraden to Coen. Some dykes are pyritic, silicified and brecciated, and carry low-grade gold mineralisation. Mineralisation, in the form of gold-bearing quartz-calcite-fluorite-pyrite veins, occurs in shears marginal to the dykes and in parallel and feather shears. Minor arsenopyrite, galena and sphalerite also occur in the veins.

In the Coen and Hamilton Goldfields, the dykes occur associated with shear-hosted gold-quartz veins and may have remobilised gold from that mineralising event.

At Flying Fox Hill, quartz vein mineralisation with up to 0.3 ppm Au is associated with porphyritic rhyodacite. Many companies have postulated an epithermal origin for veins associated with the dykes but, so far, exploration for large tonnage epithermal systems has been unsuccessful.

The style of mineralisation is described as 'porphyry-related vein and stockwork deposits' by Morrison (1988) and is widespread in north Queensland. The common association is with porphyry dykes in reactivated shear zones or in complex fault and fracture sets formed in a regional stress field during intrusion. Significant occurrences are associated with dykes of rhyolitic to trachytic composition, related to Permo-Carboniferous subvolcanic complexes. Fissure, rather than shear, lodes predominate in most deposits and individual veins have sharp walls and minor wallrock inclusions. The veins are dominated by fine, clear, elongate, euhedral quartz growing in combs, lining vughs, or as cockade overgrowths. Carbonate is a common associate and sulphides (Fe, Cu, Pb, Zn) typically constitute up to 20 % of ore shoots.

In north Queensland, **porphyry-related breccia deposits** are associated with Permo-Carboniferous subvolcanic complexes with dykes, plugs, stocks and breccias of rhyolitic to trachytic composition. There are numerous breccia bodies in northeast Queensland but only a handful contain significant gold mineralisation (Morrison, 1988).

Within the study area, the only known definite deposit of this type is at Spion Kop, south of Ebagoola. Mineralisation and weak argillic alteration closely follow the contact of a 300 m diameter rhyolite pipe intruding Flyspeck Granodiorite. Breccias along the contact zone comprise clasts of rhyolite, granite and greisen in a rhyolitic, silica and greisen matrix. The breccias contain arsenopyrite and up to 2.4 ppm Au. Gold mineralisation is associated with sulphide (pyrite + minor arsenopyrite)- quartz veins and with fractures in the granite. Past mining concentrated on an arsenopyrite-rich felsite breccia lode which assayed approximately 30 g/t Au.

Mineralisation at Spion Kop is also associated with north-trending felsite dykes in the area. A high temperature, intrusive contact breccia environment is indicated. Low temperature mineralising systems are entirely absent.

At Scrubby Creek and Packers Creek, near Iron Range, **gold-pyrite-arsenopyrite veins** occur in the late Palaeozoic Weymouth Granite. In 1980, Jahi Pty Ltd delineated proved reserves of 15 000 t at 8.78 ppm Au and 4250 t at 8.49 ppm Au in two lenticular zones at Scrubby Creek. However, further investigations by United Reefs N.L. indicated that grades were 2 to 3 ppm.

Gold mineralisation at McLennan's Lode and the White Heather, southeast of the Wenlock Goldfield, comprises **quartz veins in shear zones** in the late Palaeozoic Wigan Adamellite. Associated sulphides include pyrite, arsenopyrite, galena and chalcopyrite. The main mineralised zones are silicified breccia zones (fragments and blocks of lode quartz in silicified and sericitised granite) in dykes of fine-grained granite. The gold is generally very fine-grained; lode samples assayed 4.5 to 9.9 g/t Au.

Potential **epithermal gold mineralising systems** occur in the Bolt Head area, at Temple Bay. Drilling by Queensland Metals Corporation N.L. did not detect any anomalous gold but distinct Hg, As and Sb bedrock anomalies were intersected. Quartz-pyrite-arsenopyrite veins in narrow, linear breccia zones in ignimbrite and silicified tuff of the Kangaroo River Volcanics at Glennie Inlet assayed up to 0.55 ppm Au. The rocks are anomalous in Hg, As and Au. Ewers and Cruickshank (1993) have reported that an area of regional ^{18}O depletion (indicative of epithermal gold potential) occurs in the Temple Bay - Pascoe River area.

Gold-bearing deep-leads occur in gutters at the base of the Gilbert River Formation at Bairdsville, Top Camp and Lower Camp in the Wenlock Gold and Mineral Field. The gold-bearing wash is well-cemented and comprises well-rounded cobbles of quartz and basement rocks in a medium to coarse-grained clayey quartzose matrix.

Subeconomic grades of alluvial gold have been found in basal units of the Tertiary Lilyvale beds and Falloch beds in the Nesbit River valley and the Larsen's Creek area.

Alluvial and eluvial gold deposits shedding from lode deposits have been mined in many areas. Production has come from the Alice River, Ebagoola, Coen, Hayes Creek, Wenlock and Rocky River goldfields. Colours of gold have been reported from alluvium in most rivers and major creeks draining the Coen Inlier.

Tri-State Mining Ltd investigated the alluvial potential of Skae and Whites Creeks, north-northeast of Coen, in the 1980's and delineated inferred resources of 56.25 kg Au in Whites Creek and 89.5 kg Au in Skae Creek. The Skae Creek alluvium was mined in 1988.

Augold N.L. estimated that 5 000 m^3 of wash in a 1 m thick section in Buthen Creek, immediately downstream of the main lode workings in the Hayes Creek Goldfield, grades up to 0.33 g/m^3.

In 1985, Alberta Mines N.L. investigated the alluvial gold potential of the Rocky River, east-northeast of Coen. Stream bed gravels returned 18.83 to 21.53 g/m^3 along a 2.2 km length of the river. However, bulk samples assayed only 0.23 g/m^3 in the stream bed and much lower in terraces and flats. The high initial results were probably caused by biased sampling due to large boulders. Alberta Mining concluded that the deposits were too low grade for economic mining.

Leo Creek, where it drains the Claudie Lakeland reef, and creeks draining the Mullumbidgee reefs are considered to be highly prospective for small alluvial gold deposits. Minor illegal mining has been carried out at Leo Creek in the past and stream bed alluvium and residual soils on the banks produce good colours of gold when panned.

5.2.1.3 Yambo Inlier. A mineralisation style similar to that at Coen and Ebagoola occurs at the Balterra Reef, west of Palmerville. N.A. Adam reported rock chip assay results of up to 292 g/t Au for a 400 m strike length of a zone of **hematitic, gossanous and quartz-veined and brecciated granitic gneiss** of the Dargalong Metamorphics. Costean samples assayed up to 7.14 g/t Au. Samples collected in 1993 assayed up to 6.1 g/t Au and 4.8 g/t Ag. Samples from gossanous quartz reefs in the Fox and Fish Creek areas, west of Palmerville, assayed up to 3.6 g/t Au and 1.8 g/t Ag.

Stream bed and palaeochannel alluvial deposits in the Palmer River, near Strathleven, have been investigated in the past, but reported grades (<0.2 g/m^3) are too low for economic mining. The gold is very fine-grained and flaky.

A number of high-level alluvial terraces along the Palmer River in the Palmerville area have been investigated. Dillingham Constructions Pty Ltd identified inferred resources of 1 653 000 m^3 at an average grade of 337 mg/m^3 at Fernhill Bend; 1 119 000 m^3 at an average grade of 395 mg/m^3 at the Palmerville Crossing; and 35 000 m^3 at 255 mg/m^3 for an area of wash adjacent to the intersection of Glenroy Creek with the Palmer River.

5.2.1.4 Hodgkinson Province. **Gold-bearing chert/quartzite units** have been found in a number of places in the Hodgkinson Formation, for example, Mount Madden, Mount Buchanan, Mount Jessop, Jessops Hill, Mount Bennett and Mount Eykin. They are associated with basic volcanic flows. The chert and volcanics contain sulphide-bearing silica veins as fracture fills associated with folding. Up to 5 % pyrite and arsenopyrite is disseminated in the chert and volcanics. Overall gold grades are generally low (<6 g/t), although veins grading of the order of 30 g/t were mined at Mount Buchanan and Mount Madden. The highest gold contents are associated with fold noses and faults.

R.B. Mining Pty Ltd interpreted the deposits at Mount Madden to be exhalative chert beds within a series of finely laminated volcanic flows. Western Mining Corporation Ltd interpreted the same deposits as zones of intense surficial silicification of carbonaceous phyllite and quartz-sericite units. The gold was remobilised and concentrated in fold noses and faults during folding events.

Cambrian Resources N.L. delineated a belt of basic volcanics and exhalative cherts in the Mammoth Bend area of the Palmer River. Extensive, stratabound gossans are associated with the cherts. Rock chip samples assayed up to 2.74 ppm Au.

Auriferous, gossanous, quartz-veined chert lenses have also been found in the West Normanby Goldfield. The largest is a breccia stockwork at Mount Eykin. Samples assayed up to 2.56 ppm Au.

Substantial outcrops of hematitic chert and breccia in the Starcke No. 1 Goldfield assayed up to 2.55 ppm Au. Shear zones associated with the chert contain quartz and pyrite, and primary hematite veins occur in the chert. The breccias are also anomalous in arsenic, antimony, selenium and silver.

Numerous chert lenses, some of possible exhalative origin, crop out as prominent ridges in the Hodgkinson Formation between Cooktown and Bathurst Bay. The cherts are locally altered basic volcanic and sedimentary rocks, with some primary/syngenetic chert, generally occurring as large boudins in deformed metasedimentary rocks. Alteration minerals comprise epidote and chlorite, and magnetite is visible in hand specimen. Quartz veins and limonite-stained fractures are common. Several companies have investigated chert ridges at the Lagoon Prospect, Brown's Peak, Four Kilometre Hill, Chert Ridge, and in the "Silica Ranges" area, between Barrow Point and Bathurst Bay. Visible gold was reported to occur in one core hole at Chert Ridge and fine-grained gold was found in pan concentrates from creeks in the Bathurst Bay area. Rock chip samples have returned maximum assay results of 1.52 ppm Au for chert and 3.67 ppm Au for ferruginous breccia. Aluminous, hydrous phosphate minerals occur in discordant veinlets associated with some of the deposits.

The Ginger Pig Prospect, in the headwaters of the Granite Normanby River, may be an associated deposit type. This prospect is a garnet-cummingtonite-sulphide chert unit associated with meta-basalt. Sulphides comprise <5 % by volume and include pyrrhotite, pyrite, and traces of chalcopyrite, galena and arsenopyrite. Rock chip samples from the mineralised zone assayed up to 4.10 g/t Au. The probable metasomatism in the Ginger Pig area suggests the presence of a nearby intrusive body, possibly at depth below the deposit (Donchak & others, 1992).

The Sporing Creek Prospect is a gold-anomalous, siliceous magnetite-garnet-amphibole-sulphide unit closely associated with extremely altered microdolerite or basalt flows of the Hodgkinson Formation. This unit appears to be a distal, siliceous Fe-Mn-Mg-rich deposit of volcanic exhalative origin. Sulphides are minor (<5 %) and comprise pyrrhotite (partly altered to pyrite), minor chalcopyrite, and traces of galena and arsenopyrite.

Anomalous gold (up to 0.64 ppm) is associated with a pyritic-hematitic chert unit striking parallel to and on the western side of a fault separating the Hodgkinson Formation and the Normanby Formation at the Taipan Prospect, near the East Normanby River. Stream sediment sampling indicated anomalous gold associated with pyritic chert, carbonate-altered spilite and fine-grained carbonaceous sediments of the Hodgkinson Formation. Low-order gold (up to 0.80 ppm) occurs in fault-bounded silicification zones in spilites.

Northwest of Kings Plains Station, gold occurs in a silicified, brecciated fault zone (the "Dingo Shear") which is in the Hodgkinson Formation and is parallel to the contact with the Normanby Formation. Gold is restricted to the fault zone, which assays up to 1.12 ppm Au.

Gold has been mined from **syntectonic/synmetamorphic Au-quartz and Au-Sb-quartz veins** in the Hodgkinson Formation in the Palmer Goldfield, West Normanby Goldfield and Starcke Nos 1 and 2 Goldfields. This mineralisation style is the "slate belt veins" described by Morrison (1988).

The veins occur in late brittle to brittle-ductile shear zones crosscutting previous deformations. They show evidence of incremental quartz deposition and multiple shear movement. The main quartz textures (buck, ribbon, breccia and assimilation) are characteristic of the mesothermal environment. Ore shoots are a complex mixture of quartz and gouge. The total sulphide content is generally low (<5%) and comprises pyrite, arsenopyrite, pyrrhotite and stibnite; base metal sulphides are present as accessory minerals only. The gold is free, typically of high fineness (+900) and occurs as small irregular masses and discrete grains in quartz and intermixed with pyrite and arsenopyrite. Grades mined averaged 30 to 60 g/t Au.

The veins pinch, swell and branch and occur as groups of en-echelon veins localised in secondary brittle shears associated with larger, often regionally significant, shear and melange zones. Gold is unevenly distributed and is generally concentrated in shoots associated with dilation zones, which are caused by changes in strike; splays, lithologic contacts and fissure intersections. At Munburra, the veins are spatially related to felsite porphyry dykes. Wall rocks, particularly adjacent to gold-bearing shoots, may have narrow sericitic alteration selvedges. Brecciated margins are common.

In the Hodgkinson Goldfield (Mossman 1:250 000 Sheet area), the calculated oxygen isotopic composition of the gold-bearing fluids is 10 $\pm$ 2 per mil, which overlaps the

fields for metamorphic and primary magmatic fluids (Golding & others, 1990). The calculated hydrogen isotopic composition for the hydrothermal fluids is -100 $\pm$ 20 per mil at 300 $\pm$ 50° C. Fluid inclusion studies, together with shear zone characteristics, indicate that the veins in the Hodgkinson Goldfield formed at 270 to 350° C (assuming a fluid pressure of ~ 1 Kbar).

In summary, Golding and others (1990) postulated that the veins were deposited during regional tectonism and channelled to dilational sites in shear zones. The stable isotopic characteristics of these mesothermal auriferous fluids mainly reflect extensive fluid-rock interaction, either at source or within fluid conduits.

Morrison (1988) reported that alteration muscovite from veins in the Hodgkinson Goldfield gave a K-Ar age of Late Carboniferous. Peters (1987) suggested that the veins formed during Permian tectonism, following injection of dolerite dykes and sills and localised east-west shearing during the Early Carboniferous. The Permian tectonism was a melange-forming event, with localised high heat flows and intrusion of regional plutons (with associated Sn and W mineralisation).

Gold-bearing veins of this type form by dissolution or leaching processes in large source regions, followed by fluid transport over significant distances and precipitation in appropriate sites that are small compared with the source regions (Cox & others, 1987). Focussing of fluid flow occurs in or adjacent to high permeability fault or shear zones. Thrust surfaces, in particular, have been recognised as very important sites for channelling of fluid flow and may affectively tap fluids migrating from the underlying thrust plate. Veins are commonly developed in restricted areas in structurally-controlled sites such as around shear and fault zones, in particularly competent rock units, or in particular parts of folds.

So far, exploration for bulk-tonnage, low-grade stockwork deposits centred on these vein systems has been unsuccessful. Mineralisation occurs in rich shoots of limited extent and wall rocks and crosscutting veinlets are too low-grade to constitute a mineable resource.

Gold-quartz vein mineralisation at Six Mile Creek, 9 km west-southwest of Cooktown, occurs in sheared and highly altered acid to intermediate volcanics and intercalated silty to sandy sediments of the Permian Normanby Formation and may be related to Permian granites in the area. Mineralisation comprises **gold-stibnite-quartz vein stockworks and** breccia in shear zones. Textures are indicative of an epithermal origin (Truelove, 1986). Best drilling intersections in the area were 2 m at 0.20 g/t Au for quartz veins in the oxidised zone and 2 m at 0.59 g/t Au for a zone of intense sericite-silica alteration.

A number of **gold-mercury geochemical anomalies** have been delineated as forming a southern extension of a regional shear zone which includes the Six Mile mineralisation. These include the Ratso, Glassblower, Alkoomie, Liontamer, Festus, Gonzo and Jasper anomalies in the Kings Plains - Alkoomie area. Samples assayed up to 27.5 ppm Hg and 230 ppb Au for stream sediments, 24 ppm Hg for rock chips, and 3 ppm Au for pan concentrates. The anomalies are in the Normanby Formation and in the Hodgkinson Formation close to faulted contacts with the Normanby Formation. There is some evidence for a subsurface intrusion in the area. These prospects may represent the upper part of an epithermal system with potential to host a significant gold deposit at depth.

Gold-bearing alluvial leads occur below Tertiary basalt in the Jimmy Ah Chees Tableland and Little Palmer River areas of the Palmer Goldfield.

Alluvial and eluvial gold deposits shedding from lode deposits have been mined in many areas. Production has come from the Palmer, West Normanby and Starcke Nos 1 and 2 goldfields. Colours of gold have been reported from alluvium in most rivers and major creeks draining the Hodgkinson Province.

The Palmer River and its tributaries carry extensive deposits of auriferous alluvium. Three main types of Cainozoic alluvium/eluvium have been recognised as being associated with present-day drainage systems (Lam & others, 1991). These are:

1. Recent wash occurring within flow channels and under active sand banks.

2. Old wash lying outside the active flow channels but adjacent to recent sand banks. This wash is exposed during the dry season but inundated during flooding. It forms restricted deposits in the larger drainage systems such as the Palmer River. Deposits also form towards the junctions of smaller creeks with the major rivers.

3. High-level wash associated with old stream channels, situated some distance from the river, and forming terraces (sometimes 30 to 50 m above present river level). These high-level deposits are remnants of alluvium and wash deposited prior to downcutting of the river bed to the present, lower level. They are generally shallow but carry a higher gold content than recent river wash.

Lam and others (1991) listed the sources of the gold as:
1) auriferous quartz veins and lodes;
2) stockworks of auriferous quartz veinlets;
3) auriferous sulphide lodes;
4) auriferous sedimentary units;
5) in-situ precipitation of gold nuggets; and
6) accumulation of gold from reworking of earlier placer deposits.

In 1980, N. Adam investigated alluvium on the Palmer River at Mammoth Bend. It was inferred that there was 2.5 to 3.0 Mm^3 of potentially economic material. Costean samples gave average grades of 0.02 to 0.908 g/m^3 Au.

Investigations by Advocate Holdings Pty Ltd and Cambrian Resources N.L. indicated that Catalpa, Cradle and Jessops Creeks all contain significant gold grades. Pan concentrates assayed up to 4.12 g/m^3 Au; bulk samples averaged 2.56 g/m^3.

In 1988, Queensland Metals Corporation N.L. reported a mineable resource of 596 000 m^3 at 0.4 g/m^3 Au (with an additional 470 000 m^3 at 0.2 g/m^3) for leases it held along the West Normanby River.

J.V. Gaudion reported an indicated resource of 600 000 m^3 at 0.26 g/m^3 Au for the West Normanby River - Granite Normanby River junction.

5.2.1.5 Laura Basin. **Gold-bearing deep-leads** at the base of the Dalrymple Sandstone in the Conglomerate Range area of the Palmer Goldfield were an important source of alluvial gold in the Palmer River and its tributaries.

In the late 1980's, Gold Copper Exploration Ltd investigated the **alluvial gold** potential of the Laura River and its tributaries near Laura. Reconnaissance sampling indicated that the highest grades occur in a 10 km stretch upstream from the crossing southeast of Laura. The indicated resource was 1.3 Mm^3 at a grade of 4.2 ppm Au; platinum and palladium contents are significant.

In 1987, a total of 1380 m^3 of bulk samples from Kennedy Creek was treated for a gold recovery of 0.012 to 0.093 g/m^3; minor platinum and cassiterite occur with the gold. The alluvium was considered to be uneconomic for bulk mining.

Bulk samples of alluvium from the Mosman River returned 0.25 to 0.4 g/m^3 gold. The concentrates were high in platinum (385.5 to 840.5 ppm) and palladium (2.2 to 6.1 ppm). The indicated resource was calculated as 232 000 m^3 at a grade of 0.19 g/m^3 Au and a cutoff of 0.1 g/m^3.

5.2.2 Antimony

There has been little antimony production from the study area and most exploration of known deposits has been for their potential as gold deposits.

5.2.2.1 Coen Inlier. Approximately 30 separate antimony occurrences have been located between Dickies Creek and Jerry Dodds Creek near Kimba Homestead in the southern Coen Inlier (Figure 6). Stibnite occurs in joint-controlled **quartz veins and stockworks** in the Coen Metamorphics and granite of the Kintore Supersuite. The stibnite is associated with gold, silver, chalcopyrite and malachite in a quartz-fluorite-pyrite gangue; stibnite is extensively altered to valentinite and stibiconite. The lodes range from a few metres to more than 500 m long and a few centimetres to 2.5 m wide. Ore shoots averaging 5% antimony are interspersed with low-grade (approximately 1.5% antimony) mineralisation. Kimba Mining Pty Ltd considered the mineralisation to be epithermal veins related to the granite, but the Kintore Supersuite comprises deep-level intrusives. The potential of the deposits is limited.

Stibnite occurs in association with pyrite, arsenopyrite and galena in gold-bearing quartz lodes in the Alice River and Ebagoola goldfields. Mineralisation is related to granites of the Kintore Supersuite.

At the Whites Creek Prospect, near Coen, minor stibnite occurs with arsenopyrite in gold-bearing quartz veins in the Coen Metamorphics. The rocks are hydrothermally altered and intruded by small bodies of aplite and granite of the Kintore Granite.

5.2.2.2 Hodgkinson Province. Peters (1987) and Golding and others (1990) recognised two distinct quartz vein associations in the Hodgkinson Formation, namely, **Au-quartz veins and Au-Sb-quartz veins**. The Au-Sb-quartz veins are located in separate domains from the Au-quartz veins, or on domainal boundaries which truncate the Au-quartz veins. Golding and others (1990) suggested that the Au-Sb association postdates the Au veins. Veins of both associations are isolated into distinct structural and lithological domains by post-mineralisation faulting.

Stibnite-gold-quartz veins occur in major melange zones. The stibnite is commonly altered to cervantite. Although many of the deposits have been investigated as sources of antimony ore, most of them have been mined for their gold content only.

Deposits of this type occur at the Uncle Sandy and Cocoa Creek mines, north of Cooktown.

Minor stibnite occurs in some of the gold-quartz reefs at Munburra in the Starcke No. 2 Goldfield and has been reported to occur 5 km northeast of Palmerville.

Stibnite occurs in gold-quartz veins in the Normanby Formation at the Six Mile, near Cooktown. The veins have crystalline, open space fill textures and are in altered intermediate volcanics.

5.2.3 Tin

Tin mineralisation is known to occur in a number of distinct areas:

a) Cape York;
b) Tin Creek and First Stony Point north of the Pascoe River;
c) Granite Creek near the Archer River;
d) the Jeannie River to Cape Melville area north of Cooktown;
e) the Cannibal Creek - Granite Creek area south of the Palmer River;
f) the headwaters of the West Normanby and Palmer Rivers; and
g) the Cooktown Tinfield.

Minor mineralisation also occurs in the southern Coen Inlier.

Except for minor production from lodes at Cape York, Cannibal Creek, and in the Cooktown Tinfield, almost all cassiterite production has come from alluvial deposits. Lode deposit types include stockwork and brittle fracture types (veins and sheeted veins), greisen deposits and argillic alteration deposits, and are related to late Palaeozoic S- and I-type granites. Deposits associated with late Palaeozoic acid volcanics and intrusive porphyries at Cape York are high-level volcanic and may represent the highest level tin province in Australia. The deposits associated with I-type granites in the Coen Inlier are of the subvolcanic type. The tin lodes of the Cooktown Tinfield (S-type granites) are of the plutonic type (Gregory & others, 1980).

Figure 7 shows the general distribution of deposit types.

5.2.3.1 Cape York - Oriomo Inlier. Several small **cassiterite-bearing lodes** occur associated with altered welded tuff of the Torres Strait Volcanics and intrusive porphyries in the hills behind Punsand Bay, near Cape York. The cassiterite occurs in narrow, iron-stained, quartzose veins and veinlets occupying joint fissures (Taylor, 1969). All the occurrences are minor and the largest vein in the field, Holland's Reef (Ginger Dicks), is up to 1 m wide and was worked to only 10 m depth. It was the main producer (10.4 t of cassiterite concentrates from 142 t of ore).

A quartz reef at the Northern Mine contains an inferred resource of 200 t at 7.2 % recoverable Sn. The highest grades intersected in drillholes were 2.4 m at 0.28 % Sn and 1.5 m at 0.43 % Sn. Cassiterite-bearing veinlets in quartz-feldspar porphyry at the Fourteen Acre mine form an inferred resource of 1000 t at 0.7 % recoverable Sn.

Figure 7

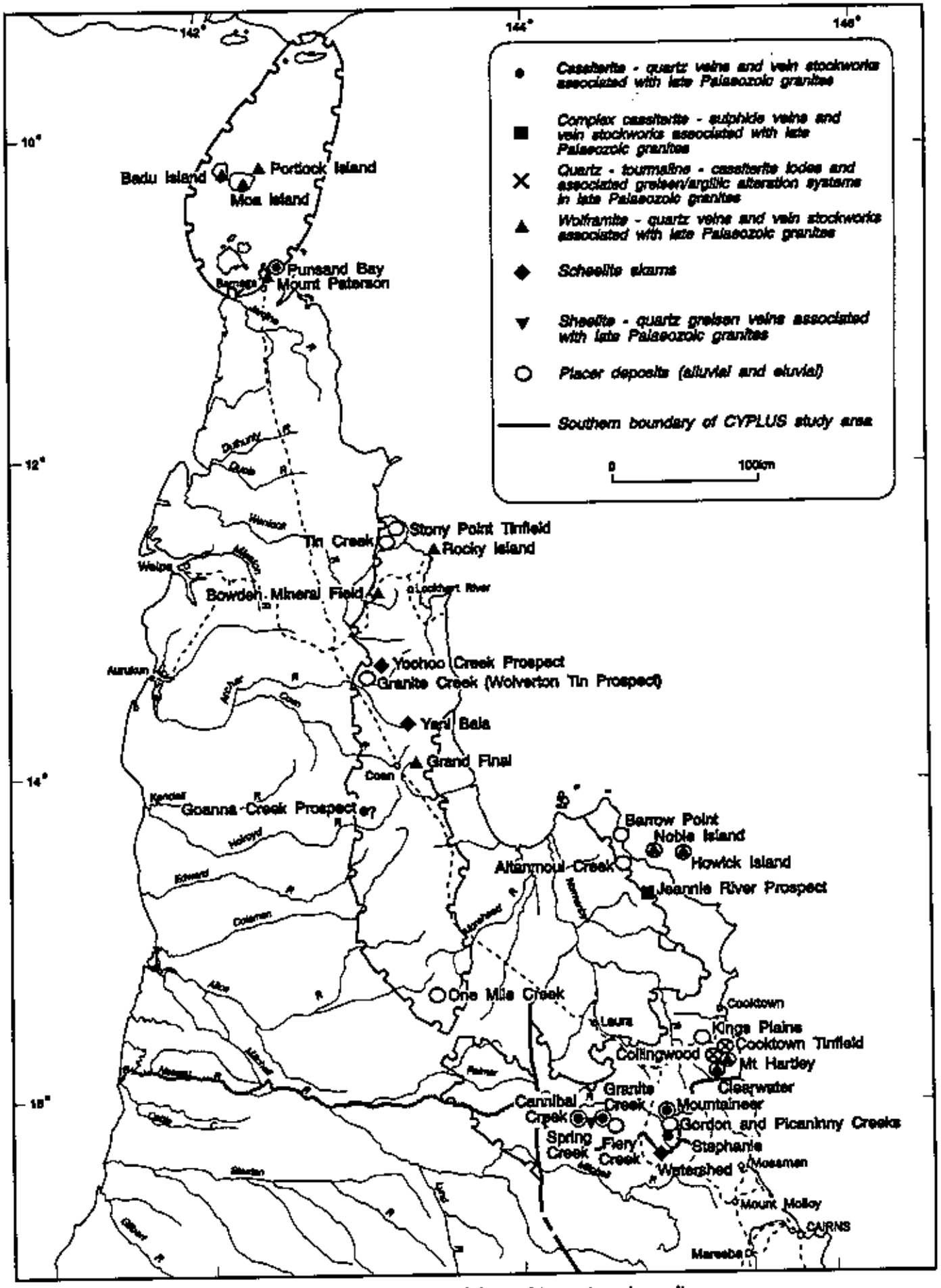

Figure 7: Distribution of tin and tungsten deposits

Coastal outcrops of porphyritic rhyolite contain numerous, small, cassiterite-bearing veinlets and have attracted some attention as potential low-grade deposits. The largest deposit occurs at the Bluffs Quarry and comprises a 1.3 m wide alteration zone with numerous narrow cassiterite veinlets. Bulk grades are extremely low (<0.10% Sn). Veinlets are too dispersed to allow large-scale mining operations (Taylor, 1969). Mineralisation is probably related to the Late Carboniferous Badu Granite and/or associated porphyritic microgranite.

Minor cassiterite occurs in wolframite-quartz veins on Moa Island.

Cassiterite has been mined from **alluvium and beach sands** in the Punsand Bay and Laradeenya Creek areas near Cape York, and has been shed from nearby quartz vein systems.

In 1968, Consolidated Mining Industries delineated a possible resource of 14.5 x 10^6 m^3 at 474 g/m^3 cassiterite and 9.2 x 10^6 m^3 at 192 g/m^3 cassiterite within an area of 20.7 km^2 of shallow alluvium. Unfortunately, the sampling and assay methods used make these results suspect. Data concerning the grain size and nature of the alluvium are lacking.

Follow-up work by Cominco in 1970 and Jimbilly Pty Ltd in 1980 to 1982 indicated that grades are generally subeconomic, except along present day drainages. Jimbilly Pty Ltd calculated an estimated resource of 448 000 m^3 grading 310 g/m^3 cassiterite for Booty and Maula Creeks. In 1981, Halekka Pty Ltd concluded that tin concentrates do not reach the grades and volumes necessary for economic mining.

Investigations of beach sand placer deposits along Punsand Bay by Consolidated Mining Industries Ltd indicated inferred resources of 0.66 Mm^3 at 193 g/m^3 cassiterite for the Lady Luck lease area. Sampling indicated that no economic concentrations occur along Punsand Beach.

5.2.3.2 Coen Inlier. The small **alluvial cassiterite deposits** at Tin Creek and the Stony Point tinfield were found to be uneconomic by BHP in 1962. It was estimated that less than one tonne of cassiterite remained in workable areas in the Stony Point field. Cassiterite was probably derived from Permian granite and associated tourmaline-bearing pegmatite veins or from cassiterite-quartz veinlets in Carboniferous to Permian acid volcanic rocks.

Detrital cassiterite concentrations in Granite and Wet Creeks, near the Archer River north of Coen, correspond to outcrops of the Permian Wolverton Adamellite and to its derived alluvial outwash material. The Wolverton Adamellite is typically quartz-veined; sericitic greisen and pegmatite veining are less common. Moderately to highly anomalous cassiterite concentrations (50 to several thousand ppm) occur in streams and creek systems draining this intrusion. Lower concentrations, with local, anomalously high concentrations, occur in older Cainozoic deposits. Although no primary mineralisation has been located in-situ, samples from the gravel dumps of recent alluvial workings indicate that cassiterite occurs along the margins of quartz veins with sericitic/greisen alteration selvedges.

In the 1980's, Wolverton Tin Pty Ltd estimated that there was 5.2 Mm^3 of alluvium in Granite and Wet Creeks suitable for dry mining by excavator and trucks and 2.25 Mm^3 of lower grade material in Wrights and Ringtail Creeks suitable for bucket-wheel dredging.

Partially exposed palaeoplacer deposits were estimated to contain more than 50 Mm^3, but grades were not known. Following further sampling, the overall potential resource of the area was estimated as up to 4.1 Mm^3 of alluvium at 1.13 kg/m^3 cassiterite. Wolverton Tin Pty Ltd and Strategic Resources Exploration N.L. (both subsidiaries of North Queensland Resources N.L.) took out ML's 3029 to 3033 and 3115. The company went into receivership in 1990 and the leases were rejected; no mining was carried out. Mining leases are still held by a number of individuals.

In 1978, CRA Exploration Pty Ltd discovered coarse-grained **cassiterite in narrow pegmatitic margins of quartz veins** in the Holroyd Metamorphics at the Goanna Creek Prospect in the southern Coen Inlier. Coarse cassiterite also occurs in the creek. No economic mineralisation was located. The source of the mineralisation is not known; no Permian granites have been mapped in the area.

In 1968, Consolidated Mining Industries located small **alluvial deposits** assaying 0.6 kg/m^3 cassiterite in the One Mile Creek area east of the Alice River Goldfield. CSR Ltd also detected very low grades of fine-grained cassiterite in the same area in 1980. The source of the cassiterite is not known; no Permian granites have been mapped in the area.

5.2.3.3 Hodgkinson Province. Minor cassiterite occurs in **wolframite-quartz veins** on Noble and Howick Islands. Cassiterite-bearing **alluvium** occurs in creeks draining granite at Barrow Point and on Howick Island.

Complex cassiterite-base metal sulphide veins and vein stockworks were discovered by Carpentaria Exploration Company in the Jeannie River area in 1979. Four centres of mineralisation (the Jeannie River, Saddle Hill, Radio Hill and Whitewater Creek Prospects) have been found but only the Jeannie River Prospect has been tested at depth by diamond drilling.

Mineralisation comprises cassiterite-base metal sulphide-quartz veins in the Devonian Hodgkinson Formation and is probably related to a porphyritic phase on the margins of the Permian Puckley Granite. The prospects are characterised by outcropping gossanous lodes, anomalous stream sediment geochemistry and magnetic anomalies.

Ore minerals in the veins include cassiterite, pyrite, pyrrhotite, sphalerite, galena, chalcopyrite, arsenopyrite and scheelite, with rare tetrahedrite, stannite, bornite and sulphosalts. Gangue minerals include quartz, chlorite, calcite, muscovite, siderite, tourmaline and axinite. Wall rock alteration is common close to mineralisation and comprises silicification, sericitisation and propylitic alteration (calcite, pyrite/pyrrhotite, epidote, chlorite). Minor tourmalinisation has also been noted.

A possible resource of 6.7 Mt of mineralisation at a grade of approximately 0.8% tin has been indicated by exploration to date (Lord & Fabray, 1990). The best drill intersections were 0.8 to 5.5 m grading 0.70 to 3.87% tin over a strike length of 1300 m in five core drillholes.

Cassiterite occurs in discrete, narrow, **quartz-greisen** lodes crosscutting the Hodgkinson Formation at Cannibal Creek. The main zone of mineralisation has a strike length of 400 m and width of 60 m. This zone contains pegmatitic quartz veins with minor cassiterite, scheelite, chalcopyrite, pyrite and beryl. The cassiterite is erratically

distributed but generally occurs as coarse to very coarse-grained crystals on vein margins, particularly within muscovite-rich zones. The host rocks are silicified and greisenised adjacent to the veins. Minor cassiterite-quartz-greisen veins also occur at Granite Creek.

Alluvial cassiterite has been mined from Cannibal and Granite Creeks and their tributaries, The primary source is narrow, quartz-greisen veins associated with granite intrusions. Alluvial cassiterite has been mined from Nine Mile, Tin and Fiery Creeks, which drain the Cannibal Creek Granite.

Fine-grained cassiterite occurs irregularly within **greisenised rocks** around the margins of the Windsor Batholith, in the headwaters of the West Normanby and Palmer Rivers. Tin lodes are known to occur at the Stephanie and Mountaineer mines.

Tin mineralisation at the Stephanie mine is associated with two subparallel **quartz veins** within a coarse-grained porphyritic granite dyke. Minor arsenopyrite, scorodite, cassiterite and granite fragments, and traces of pyrite, chalcopyrite and malachite occur in zones along the vein margins. Cassiterite also occurs within the granite adjacent to the veins.

Small, narrow, **cassiterite-bearing quartz-greisen veins** occur in the Hodgkinson Formation at the Mountaineer mine, within 1 km of the Windsor Batholith. The Mountaineer claim has also been mined for **alluvial cassiterite.**

A number of primary tin mineralisation styles are evident in the Cooktown Tinfield. These include sheeted quartz-tourmaline lodes and veins, greisen veins, greisen alteration zones and argillic alteration zones. The most important deposits historically were extensive greisen and argillic alteration zones on the margins of granite intrusions. These deposits are generally low-grade, but are deeply weathered and proved amenable to hydraulic sluicing. Recent exploration has centred on the potential of sheeted vein systems in the granite and in the overlying Hodgkinson Formation.

A **cassiterite-bearing greisen** at the Sandhills Prospect, near Mount Hartley, contains 14 963 loose cubic metres at 0.74 kg/m^3 cassiterite and 28 416 loose cubic metres at 0.66 kg/m^3. The deposit is a 300 m long by 150 m wide by 4.5 m deep zone of eluvium and weathered greisen.

In 1986, the Shell Company of Australia Ltd discovered a substantial **sediment-hosted vein system** at Mount Hartley. Rock chip samples of ferruginous tourmaline-arsenopyrite-cassiterite-muscovite-quartz veins in tourmalinised metasedimentary rocks assayed up to 12.8 % Sn.

A 100 to 250 m wide zone of **quartz-tourmaline-cassiterite mineralisation** occurs in granite close to the contact with the Hodgkinson Formation at Mount Amos. Lodes within this zone comprise 1 to 2 m wide veins and lenses of tourmaline-quartz rock with adjacent silicification and greisenisation. Mineralisation includes cassiterite, arsenopyrite and pyrite, with minor wolframite, molybdenite, native copper, galena and bismuth. The ore bodies are small, pipe-like shoots which are developed where greisenised veins and shears crosscut the lodes. The main concentrations of mineralisation are at the old Phoenician and Dreadnought mines. Similar mineralisation occurs at the Lion's Den workings on the Big Tableland.

A small **greisenised granite** deposit at Mount Poverty contains an inferred resource of 20 000 m^3 of erratic tin mineralisation. The best result from core drilling was 21 m at an average grade of 0.42 % Sn; most assay results were <0.1 % Sn. The greisen seams comprise quartz + muscovite + chlorite. Some of the chloritic greisen contains appreciable chalcopyrite as blebs and stringers.

The **Collingwood Tin Prospect** was discovered by the Shell Company of Australia Ltd in 1979. Geological investigations indicated a resource of 4.035 Mt at 0.73 % Sn (29 616 t of contained tin). It is covered by ML 2796 which was purchased by Shell in 1983. In 1984, Shell entered into a joint venture with North Broken Hill Ltd to proceed with underground exploration of the prospect. An adit was excavated along the main mineralised zone. Underground drilling indicated probable reserves of 3 106 980 t at 0.90 % Sn (27 833 t contained Sn), with a more readily extractable resource of 2 027 609 t at 1.00 % Sn (20 330 t contained Sn) (Miezitis & McNaught, 1987).

The prospect is a subsurface, granite-hosted, **mineralised greisen vein system** which is 50 m below the ground surface and is associated with the margin of the Collingwood Granite. Three types of endogranitic mineralisation have been recognised, namely, steep siliceous sheeted veins, albitic veins, and flat-lying greisen (Jones & others, 1990). Most of the cassiterite is associated with en-echelon zones of siliceous, sheeted quartz-tourmaline and greisen veins, Associated minerals include chlorite, fluorite, apatite and sulphides (chalcopyrite, bornite, chalcocite, pyrite, arsenopyrite, stannite, sphalerite and bismuthinite). Mineralisation extends over a strike length of 950 m and has a vertical extent of 50 to 130 m depth. Albitic veins within the siliceous vein system are generally small but they contain the highest grade mineralisation. Flat-lying greisen zones are confined to small cupolas and irregularities in the granite-sediment contact.

Oxygen and hydrogen isotope studies of granite and greisen from the prospect have indicated that similar fluids were responsible for both the pervasive alteration of the granite and for fracture-controlled tin mineralisation (Golding & others, 1990). Re-equilibration of magmatic fluids with the cooling granite prior to the deposition of vein minerals has been inferred.

Since the completion of underground exploration in 1986, the investigation camp has been in a care and maintenance phase. Prefeasibility studies were completed in 1987 and an environmental impact assessment study was submitted in 1988. Several leases (ML's 3065 to 3070) were granted in 1989. Mining and metallurgical options have been fully investigated. Shell is currently looking for a buyer for the prospect.

Greisenised, chloritised and silicified granite also occurs at Mount Misery. **Greisen** occurs as near-vertical, sheet-like bodies in shear zones with included subvertical veins. Cassiterite, chalcopyrite, arsenopyrite, sphalerite and pyrite occur in the greisen zones and chalcopyrite and pyrite occur in altered granite; tourmaline is an ubiquitous accessory mineral. The mineralisation style is probably similar to that at Collingwood, but the granite and associated mineralisation are at about 400 m depth.

The Cooktown Tinfield has been the major producer of **alluvial cassiterite** in the CYPLUS area. Cassiterite is found in recent stream channel alluvium, in eluvial deposits shed from stanniferous lode systems, in alluvial terraces adjacent to the main streams, in perched terraces well above present stream levels, in ferruginous gravels on high tablelands such as Mount Poverty, and in deep leads below Tertiary basalt flows.

The main centres of production were Rossville, Mount Poverty, Upper Romeo, Shiptons Flat, Grasstree, Big Tableland, Little Tableland, Mount Hartley, Mount Finlayson, Tabletop and Mount Amos.

The Annan River, from its headwaters down to the Helenvale area, is known to contain alluvial cassiterite at subeconomic grades.

Alluvial cassiterite is also known to occur in the Mount Misery, Mount Boolbun North and Mount Boolbun South areas. The rugged topography and limited access of these areas has meant that there has been little mining activity or prospecting.

Large resources of alluvial cassiterite occur in an abandoned stream channel extending west from Waterfall Creek to Trevethan Creek. In 1967, Eastern Prospectors Pty Ltd calculated an inferred resource of 0.95 Mm^3 of alluvium at an average grade of 482 g/m^3 cassiterite. In 1978, Serem Australia Pty Ltd assessed the deposits and calculated overall indicated resources as 2.1 Mm^3 at an average grade of 383 g/m^3, comprising 0.9 Mm^3 of wash at an average grade of 759 g/m^3 cassiterite and 1.2 Mm^3 of overburden.

Alluvial flats along Mungumby Creek, at the base of the Big Tableland, contain an indicated resource of 595 125 m^3 at 0.20 kg/m^3 cassiterite or 434 760 m^3 at 0.43 kg/m^3.

Alluvial flats along Mount Hartley Creek, below Mount Hartley, contain indicated resources of 381 440 m^3 at 0.18 kg/m^3 in the lower terraces and 453 125 m^3 at an unknown grade in the upper terraces.

Older, high-level alluvium occurs in the headwaters of Granite Creek, between Mount Hartley and Mount Amos. Shallow, gravelly clay upslope from the present stream grades up to 10 kg/m^3 cassiterite (average 1.5 kg/m^3). Cassiterite occurs in pisolitic, lateritised clay on low ridges and alluvial terraces.

The Kings Plains Prospect was first recognised on air photographs by K.G. Lucas and was subsequently confirmed by ground examination by K.G. Lucas and L. Cutler during geological mapping of the Cooktown 1:250 000 Sheet area by the Bureau of Mineral Resources and the Geological Survey of Queensland. The prospect is a former channel of the Annan River and was first described by Best (1962). Investigations by the Bureau of Mineral Resources and Queensland Department of Mines indicated that the ancestral Annan River valley is deeply incised and is at least 50.3 m deep in places. The alluvium is stanniferous, the best grades being concentrated at depths of >30.5 m. Mungumby Creek (and therefore the Big Tableland) may have been a major contributor of the cassiterite.

In 1965, Eastern Prospectors Pty Ltd drilled 304 scout holes in the Kings Plains area. Samples were assayed and basement contour maps were prepared. The inferred resource was calculated to be 128 Mm^3 at 119 g/m^3 cassiterite, suitable for dredging over a depth of 42.7 m.

M.H. Wood assessed the Kings Plains deposit as a dredging proposition in 1975. The inferred resource was calculated to be 87 Mm^3 at an average grade of 130 g/m^3 cassiterite (cutoff 77 g/m^3). The eastern section of the deposit is the richest (42 Mm^3 at an average grade of 160 g/m3 cassiterite). It was concluded that the deposit may be physically dredgeable but the grade is too low to be economic.

From 1977 to 1983, Triako Mines N.L., in a joint venture with Serem (Australia) Pty Ltd and Buka Minerals N.L., investigated the potential of the Kings Plains deposit for a dredging or gravel pumping operation. Percussion drilling indicated the presence of two mineralised horizons in the wash, separated by a zone with very low grades. The best grade intersected was 10 m of wash at 267 g/m^3 cassiterite. The alluvium deepens to the west, with an accompanying lowering in grade.

Norminco Pty Ltd applied for ML 40070 over the prospect in June 1993.

Carpentaria Exploration Company Pty Ltd examined **clayey slopewash and colluvial deposits** at Grasstree Pocket and inferred a resource of 1 Mt at an average grade of 138 g/t cassiterite.

Cassiterite-bearing wash occurs as **deep-leads** below basalt, much of which is deeply weathered, in the Shiptons Flat - Bairds Creek area.

Dominion Mining N.L. calculated that there is an inferred resource of 96 449 m^3 of **eluvium** at a grade of 0.55 kg/m^3 cassiterite (0.2 kg/m^3 cutoff) at the Just In Time claim on Mount Hartley.

5.2.4 Tungsten

Tungsten mineralisation tends to occur in the same general areas as tin and is also related to late Palaeozoic granites (Figure 7). However, individual tungsten provinces are separated from or overlap the tin provinces. Scheelite skarn mineralisation in the Coen Inlier may be related to mid-Palaeozoic granites.

5.2.4.1 Cape York - Oriomo Inlier. Wolframite occurs in **joint-controlled quartz lodes** on Moa Island in the Torres Strait. The main deposits are at Eet Hill, Blue Mountains (Mount Augustus) and near Kubin Village. The lodes occur in the Carboniferous Badu Granite and in hornfelsed Torres Strait Volcanics close to the granite contact. Wolframite has also been found at several other places on Moa Island and on adjacent islands (Badu Island, Portlock Island, North Possession Island). Wolframite has also been reported to occur on the mainland at Mount Paterson, 20 km southwest of Cape York.

The lode at Eet Hill is a fissure-filling, chloritised quartz vein system with pyrite, arsenopyrite, chalcopyrite, marcasite and wolframite; chloritic and sericitic alteration occur along the vein margins. Shoad wolframite was also mined.

5.2.4.2 Coen Inlier. **Wolframite-quartz veins** occur in a 2.5 km long by 1.5 km wide zone of mica schist of the Sefton Metamorphics in the Bowden Mineral Field. The lodes are up to 2 m wide and are generally concordant with the strike and dip of the schist. Wolframite, with minor intergrown scheelite and tungstite, is commonly concentrated in bunches in the quartz and, in places, is accompanied by tourmaline, molybdenite, arsenopyrite, pyrite, galena and bismuthinite. The wall rocks are greisenised and tourmalinised. Mineralisation is related to the Permian Weymouth Granite; similar veins occur in granite on Rocky Island near Portland Roads.

A small deposit of wolframite and molybdenite occurs at the Grand Final, 12 km east of Coen. Wolframite occurs as bunches in a quartz vein in the Silurian to Devonian

Lankelly Granite. Mineralisation may be related to an unexposed intrusion of the Permian Twin Humps Adamellite.

Wolframite occurs in minor amounts with **alluvial cassiterite** in streams draining the Wolverton Adamellite in the Granite Creek area.

Scheelite occurs in weakly mineralised **skarns** in the Proterozoic Holroyd Metamorphics at Yoohoo Creek, northeast of the Wolverton Tin Prospect. Massive scheelite occurs in marble and disseminated scheelite/molyscheelite occurs in diopside±tremolite±epidote±calcite±vesuvianite±garnet rocks, which probably represent altered and pegmatite-contaminated calcareous sedimentary rocks. The metamorphic grade of the host rocks is upper greenschist facies with superimposed contact hornblende hornfels facies. Quartzofeldspathic gneiss and quartz-muscovite pegmatite associated with the skarns appear to represent injections of magma of the Silurian to Devonian Kintore Granite, but the source of the mineralisation could equally have been the adjacent Wolverton Adamellite. Mineralisation is widespread but is nowhere present in sufficient concentrations to be economic.

Minor **scheelite** has been reported to occur in **calc-silicate rocks** in the Coen Metamorphics at the Yani Bala leases near Leo Creek. Base metal sulphide-bearing quartz veins occur in the same area. Mineralisation is related to either the McIlwraith Granite or the Twin Humps Adamellite.

5.2.4.3 Hodgkinson Province. Wolframite is known to occur at two locations in the Cooktown Tinfield. Zones of **quartz-tourmaline-wolframite-sulphides veining** at Mount Hartley assay up to 0.12 % W, 800 ppm Cu and 250 ppm Bi. The granite host is greisenised, silicified and tourmalinised adjacent to the veins.

Rock chip samples at the Clearwater Prospect, near Romeo Creek, assayed up to 0.76 % Sn and 1.18 % W. Wolframite, scheelite and cassiterite occur in **sheeted quartz-tourmaline and quartz-feldspar veins** in argillised and unaltered microgranite and granite. Silicification and greisen alteration occur in granite adjacent to the veins.

Wolframite has been mined from **quartz vein stockworks** in hornfelsed Hodgkinson Formation on Noble Island. Locally, the veins contain up to 5% wolframite and arsenopyrite. Scheelite may also occur. Mineralisation is probably related to the Permian Altanmoui Granite.

Quartz-cassiterite-wolframite veins have been reported to occur in the Puckley Granite on Howick Island.

Minor **wolframite-quartz veins** occur in the headwaters of Gordan and Picaninny Creeks, on the western side of the Mount Windsor Tableland.

Scheelite occurs in **quartz-greisen veins** in tourmalinised metasediments of the Hodgkinson Formation at Spring Creek, near Cannibal and Granite Creeks. Coarse-grained crystals and aggregates of scheelite occur on vein margins and within muscovite-rich portions of the veins. Scheelite also occurs in anastomosing veinlets in the alteration halo of the lodes and as disseminations within the tourmalinised host rocks. The veins comprise pegmatitic quartz, muscovite and scheelite, with minor cassiterite, chalcopyrite,

pyrite, beryl, and selvedges of tourmalinised host rock. A granitic pluton (Cannibal Creek Granite) has been intersected at 75 m depth in drillholes.

Minor **scheelite** occurs in the **quartz-cassiterite-base metal sulphide veins** of the Jeannie River Prospect.

Scheelite also occurs as disseminated grains in calc-silicate rocks of the Hodgkinson Formation and in quartz-greisen veins in the calc-silicate rocks and intruding granites. The Watershed deposit is a steeply-dipping body of **calc-silicate rocks** in the hinge zone area of a megafold. Scheelite occurs as fine- to coarse-grained disseminations in the host rock and as coarse crystals in quartz-calcite veins. Within the calc-silicate rocks, the scheelite is accompanied by minor pyrite, pyrrhotite, arsenopyrite, fluorite, sphalerite, chalcopyrite and molybdenite. Scheelite is concentrated along vein margins, but also occurs within muscovite-rich portions of the veins. Pyrrhotite and arsenopyrite are commonly associated with the vein scheelite. Resources have been reported as 14 Mt at 0.3 % WO_3 (Miezitis & McNaught, 1987). The prospect is held under MDL 127 by BHP Australia Coal Ltd.

There is no recorded production of **alluvial or eluvial wolframite** from the study area, but shoad wolframite was probably mined on Noble Island. Gingell (1956) estimated that talus slopes surrounding the peaks on Noble Island carried 3.5 kg/m^3 wolframite and could support a small-scale mining operation. Wolframite and quartz vein debris occur embedded in coral on the island. Shoad wolframite has also been reported to occur in the Altanmoui Range.

A small amount of **scheelite** (0.5 to 1%) was recovered with **alluvial cassiterite** in the Mountaineer area, at the head of the West Normanby River. The primary source has not been determined.

5.2.5 Molybdenum

The only recorded production of molybdenite in the study area was 127 kg of concentrates from the Grand Final lease, east of Coen (Figure 6), where molybdenite occurs on the margins of a **quartz-wolframite vein.** Traces of molybdenite also occur associated with quartz-wolframite veins in the Bowden Mineral Field, on Rocky Island near Portland Roads, and on Moa Island in Torres Strait. A quartz-molybdenite vein has been reported to occur on Barrow Island. Molybdenite occurs as rare traces in some of the tin lode systems in the Cooktown Tinfield. None of the occurrences represents a significant deposit.

5.2.6 Base metals

Figure 8 shows the distribution of base metal deposits and occurrences in the study area.

5.2.6.1 Cape York - Oriomo Inlier. Minor **copper mineralisation** is common in the southern part of the Cape York - Oriomo Inlier. Mineralisation occurs mainly as chalcopyrite, partly oxidised to malachite and azurite, in **quartz-veined and hydrothermally altered fracture zones** in late Palaeozoic welded tuff and porphyritic microgranite.

Figure 8

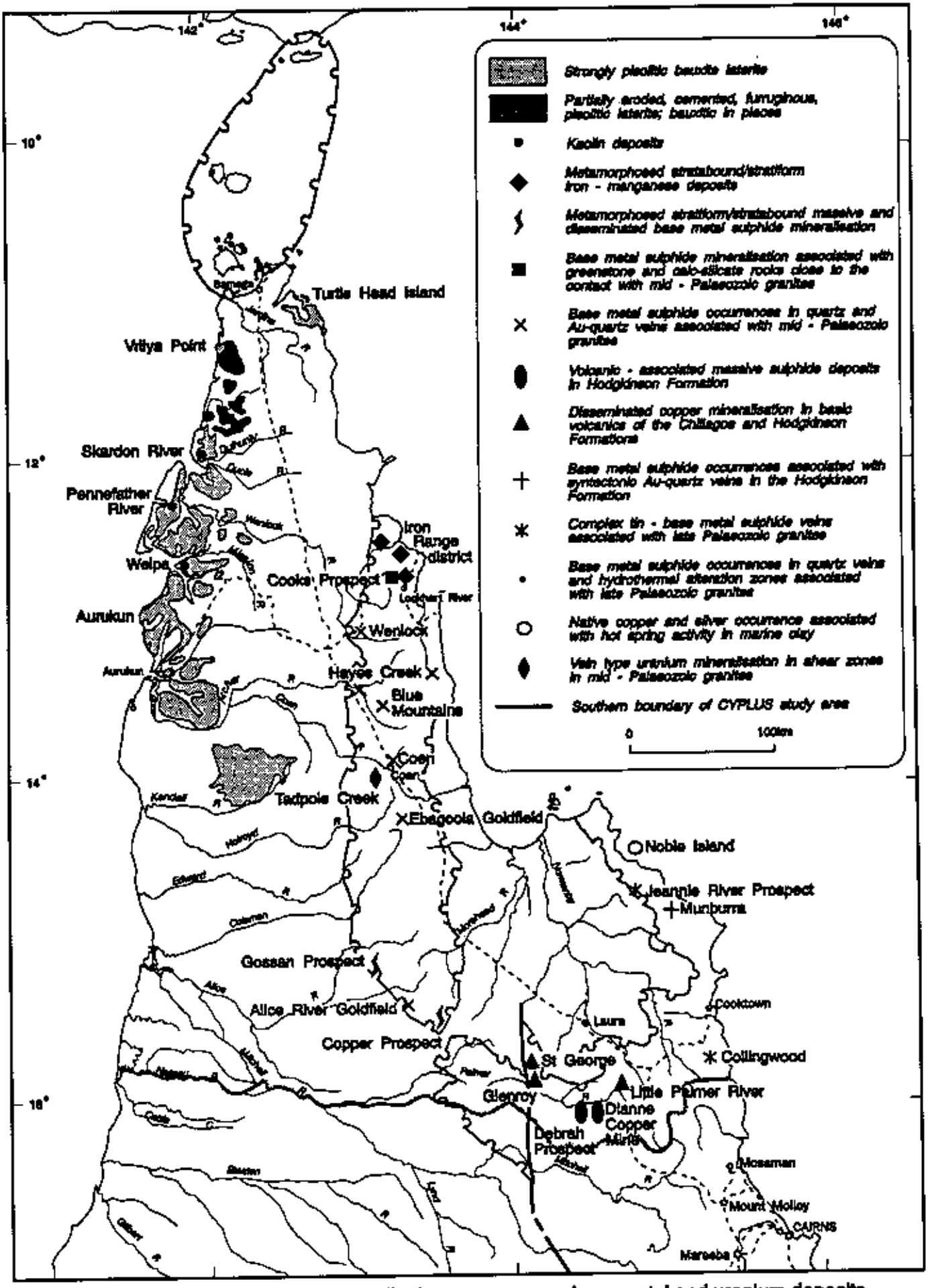

Figure 8: Distribution of bauxite, kaolin, iron-manganese, base metal and uranium deposits

Occurrences have been reported from Hammond, Horn, Badu, Moa, Booby, Goods, Thursday and Possession Islands, Pai Bai Tud Islet, and Peak Point and some of the tin lodes on the mainland. Galena and sphalerite are common accessory minerals in gold-quartz veins in the area, particularly on Horn Island and Possession Island.

5.2.6.2 Coen Inlier. In the Iron Range district, minor **malachite and azurite** and traces of pyrite, galena and chalcopyrite occur in minor **shear zones in greenstone bands** of the Sefton Metamorphics south of the Claudie River. Mineralisation is close to the contact of calc-silicate rocks and the Kintore Adamellite. At Cooks Prospect No. 1, minor malachite and azurite and traces of pyrite and chalcopyrite are related to shearing in greenstone. One sample assayed 1.65% copper. At Cooks Prospect No. 2, a galena-bearing gossan assayed 23.6% Pb and 0.1% Cu.

Minor **copper, lead and zinc sulphide mineralisation** is associated with **quartz veins and gold-quartz veins** associated with mid-Palaeozoic granites in the northern Coen Inlier. Galena is the most common of these sulphides.

Near Potallah Creek, the Holroyd Metamorphics host **stratiform/stratabound massive and disseminated base metal sulphide mineralisation** (iron, copper, lead, zinc and minor silver and gold) (Bain & others, 1990). Mineralisation occurs in an intensely sericitised zone in the "Lukin Schist", an informal field subdivision of the Holroyd Metamorphics. The "Lukin Schist" comprises a layered sequence of alternating graphitic and sericitic siltstone and subordinate greywacke and altered mafic volcanic rocks. The sequence is isoclinally folded, has a strong penetrative cleavage, and is metamorphosed to upper greenschist - lower amphibolite grade.

The Gossan Prospect, 4.8 km southeast of the Perseverance Mine at Potallah Creek, is a **stratiform polymetallic massive sulphide body** hosted by a black shale sequence and associated with basic igneous rocks. Mineralisation is discontinuous and patchy and is confined to a shear zone near the contact with the Kintore Adamellite.

Reconnaissance drilling has indicated a 0.7 to 1.8 m thick deposit, at least 200 m by 250 m in area and containing up to 8.5% total sulphides. Assays of drill samples gave grades of 0.37 to 0.46% Cu, 1.68 to 11.51% Pb, 2.13 to 6.36% Zn, 19.7 to 94 ppm Ag and 0.2 to 0.6 ppm Au. Primary sulphides include chalcopyrite, galena and sphalerite. The surface expression of the mineralisation is a highly altered, brecciated, leached and partly gossanous rock. From 1978 to 1980, Anaconda Australia Incorporated carried out percussion drilling and calculated an indicated resource of 50 000 t of ore with 10% combined copper, lead and zinc sulphides. The deposit is not exploitable on a large scale.

The Copper Prospect, east-southeast of the Alice River Goldfield, is a **copper-nickel mineralised ?dyke** of metamorphosed ultramafic rock. Mineralisation is stratabound and is associated with fractured rocks in the southeastern portion of the outcrop. Copper occurs as malachite (replacing talc or tremolite) and as minor cuprite. Nickel probably occurs as nickel-bearing silicate. Costean samples assayed up to 1.42 % Cu and 1.19 % Ni.

Galena is a common accessory mineral in the **gold-quartz vein deposits** of the Alice River, Potallah Creek and Ebagoola goldfields.

5.2.6.3 Yambo Inlier. No base metal mineralisation has been found in the Yambo Inlier.

5.2.6.4 Hodgkinson Province. Minor sphalerite, galena, chalcopyrite, bornite and tetrahedrite occur in the **cassiterite-quartz** veins of the Jeannie River Prospect. Minor galena is associated with some of the **gold-quartz reefs** at Munburra.

Native copper and silver, with a little gold, occur in uneconomic quantities below the high water mark on the eastern side of Noble Island. Mineralisation occurs as small threads and beads in black and yellow clays at 2.5 m depth below a surface of coral and sand. Apparently, the metals were deposited by reduction from **hot spring water**.

Minor copper mineralisation occurs associated with **tin and tungsten vein systems** at Cannibal Creek, Spring Creek and in the Cooktown Tinfield.

Volcanic-associated massive sulphide deposits occur in the Hodgkinson Formation at the Debrah prospect and the Dianne Copper Mine.

These deposits comprise predominantly chert/quartzite beds associated with basic volcanic (spilitic) sills or flows. The tabular-shaped orebodies are >100 m long and are capped by ferruginous gossans. The sulphide zones contain pyrite bands replaced by chalcopyrite, sphalerite and galena (Fe>>Cu>Zn>>Pb and Ag>>Au). Past mining has been confined to secondary enrichment carbonate zones grading 20 to 25 % Cu.

The Debrah Prospect and other copper prospects in the Mount Bennett area comprise discontinuous lenses of pyritic quartzite which have a gossanous expression and are anomalous in copper. There is a potential for massive sulphide deposits at depth.

The Dianne deposit is a stratiform copper- and zinc-rich, tabular, pyritic massive sulphide body which forms a steeply-pitching lens within an overturned sequence of interbedded shale and greywacke. The orebody is more than 150 m long and is capped by a ferruginous gossan. Along strike, the massive sulphides grade into a thin, pyritic chert and, locally, stratabound pyrite, chalcopyrite and minor sphalerite occur in a sericitic shale. Supergene enrichment has occurred to approximately 100 m depth. Past mining concentrated on the supergene enriched zone, which contained ores assaying up to 25 % copper. Drilling intersected primary mineralisation with a grade of 3.8 % Cu over 5 m.

Gregory & Robinson (1984) concluded from sulphur isotope studies that the ore fluid was dominantly of magmatic origin. A decrease in temperature and fluid mixing with seawater probably initiated the precipitation of the ore minerals. No stockwork mineralisation is evident, apart from minor sulphide veining in chert beds in the footwall. Mineralisation may have formed distally from the source of the ore fluids.

Copper-mercury deposits in the Glenroy Creek - St George Copper mines area, north of Palmerville, occur in narrow, discontinuous lenses of basic volcanics and breccias interbedded with silicified sediments of the Chillagoe Formation. Mineralisation comprises chalcopyrite, chalcocite, malachite, native copper and cinnabar as disseminations and fracture fills and in quartz and calcite veins.

An area of **basic volcanics and chert** of the Hodgkinson Formation in the Little Palmer River area contains minor copper mineralisation (chalcopyrite and copper carbonates). The highest assay result was 380 ppm Cu for a gossan sample.

5.2.7 Uranium

Despite fairly extensive exploration for sedimentary and vein style uranium mineralisation, only one occurrence of definite uranium mineralisation has been found in the study area.

The Tadpole Creek Prospect (CRA Hill Prospect) (Figure 8) comprises **disseminated secondary uranium mineralisation** (autunite and metatorbernite) in mylonite and thin, concordant quartz veins in a shear zone in the Kintore Granite. The shear zone is radioactive for a length of 1300 m and width of 0.7 to 2.4 m, but the highest uranium content intersected in drillholes was only 350 ppm. Minor gold is associated with the uranium.

Radiometric anomalies elsewhere in the study area have generally proved to be due to accumulations of **monazite in alluvial deposits**.

In 1972, Horizon Exploration Ltd delineated palaeo-stream channels incised in the Hodgkinson Formation and Permian granitic rocks at the base of the Laura Basin sequence, east of Laura, and considered the channels to be a suitable environment for **Colorado Plateau type uranium deposits**. Roll-front colour banding was found in quartzo-feldspathic sandstone of the Gilbert River Formation. Rock chip samples indicated a limited to no potential for sedimentary uranium deposits.

5.2.8 Iron and manganese

Metamorphosed, stratabound/stratiform iron-manganese deposits occur in the Iron Range area (Figure 8). They comprise steeply-dipping lenses of magnetite and hematite-bearing schist and quartzite within the Sefton Metamorphics. The lenses locally contain traces of gold, possibly confined to small quartz veins in the schist.

The deposits were investigated by the Broken Hill Pty Company Ltd between 1957 and 1962 and contain about 1.0 Mt of indicated resources ranging from 54 to 62 % iron (including manganese) and 300 000 t of inferred resources containing 45 to 55 % combined iron and manganese. The small size of individual deposits renders them uneconomic.

BHP identified two types of iron deposits in the area. The southern type is in the Lamond Hill area and comprises hematite and quartz with some magnetite and very minor manganese minerals. The northern type is in the Black Hill area and consists of magnetite and quartz with lesser amounts of manganese oxides, rhodochrosite, calcite, pyrite and pyrrhotite. Petrological studies have indicated that most rocks of the ore zones have been derived from ferruginous siltstones by low to medium-grade metamorphism; some of the ore lenses may be metamorphosed basic rocks.

Highly oxidised manganese-rich residual cappings form an important part of the ore reserves of both deposit types. These cappings of massive ore may have formed by metasomatic replacement of silica, in iron-formation rocks, by iron and manganese oxides

under the influence of meteoric water (Canavan, 1965). Scree has formed by mechanical breakdown of the massive ore and also forms an important proportion of the total resource.

5.2.9 Bauxite

Aluminous laterite extends, with minor erosional gaps, for a distance of 350 km along the west side of Cape York Peninsula, from Vrilya Point in the north to the Holroyd River in the south (Figure 8), and covers an area of approximately 11 000 km^2, of which at least 520 km^2 contains economic grade bauxite (Evans, 1975). The bulk of the bauxite is in 2 500 km^2 of mining leases held by Comalco Aluminium Ltd. Small residuals of aluminous laterite occur beneath a cover of dune sand on Turtle Island and east of the Escape River on the eastern side of Cape York.

In the Weipa Peninsula area, the laterite has developed on the "Weipa beds", a fluvial or deltaic unit overlying the Early Cretaceous, shallow marine Rolling Downs Group. The basal unit of the Weipa beds is a coarse quartz sandstone, overlain by interbedded kaolinitic clay and quartz sand. Bauxite has formed in the upper part of this sequence. North and south of the Weipa Peninsula, the aluminous laterites have formed on sediments of the Rolling Downs Group. Recent drilling by Comalco has indicated that the Weipa beds may be a facies of the Rolling Downs Group (Schaap, 1990).

The aluminous laterites are almost entirely restricted to the thicker Cretaceous to Tertiary sediments close to the present coastline. Inland, where Jurassic and Cretaceous sediments have been lateritised, the profiles are ferruginous, sandy, devoid of pisolites, and non-bauxitic.

The bauxite deposits formed by in-situ weathering of the underlying sediments. The bauxite is considered to be the result of in-situ weathering of the Weipa beds during the normal process of lateritisation. This is supported by the widespread field evidence of bauxite-coated fragments of the original sediments. In the Pera Head area, a quartz pebble zone found in the underlying sediments can be traced up-dip into the overlying bauxite. Additionally, the heavy mineral suite found in the bauxite layer is similar to that of the underlying weathered strata. The pisolitic bauxite is thought to have been concentrated within the zone of fluctuation of the old water table (Evans, 1975). Topographic position and porosity/permeability may have been important factors in determining the distribution of economic deposits.

The typical weathering profile is 20 to 35 m deep and boundaries are gradational. The profile comprises:

a) Laterite zone - 0.5 m soil, 1 to 5 m bauxite, 1 to 2 m ironstone;
b) Mottled zone - characterised by decreasing iron content with depth; stained by red and yellow iron oxides;
c) Pallid zone - relatively low in free iron oxides; Weipa beds are white; kaolin deposits occur in Weipa area;
d) Saprolite zone - transition between pallid zone and unweathered sediments.

The bauxite layer is a flat to gently dipping surface deposit averaging 2.4 m thick, with <1 m of overburden. The bauxite is strongly pisolitic and generally loose and friable. Pisolites are <1 mm to 20 mm in diameter and occur in a sandy matrix. Available alumina is present in two varieties - gibbsite (trihydrate) and boehmite (monohydrate).

Silica content (combined silica and quartz) is 1 to >10% and there are both low- and high-iron varieties.

In its 1992 Annual Report, Comalco reported total bauxite reserves of 248 Mt and a total resource of 3700 Mt for its ML 7024 (formerly SBML 1).

Alcan South Pacific Ltd holds ML 7031 (formerly SBML 8) which extends from north of Weipa to the Dulhunty River. The lease is reported to contain 75 Mt of bauxite (White, 1991).

Aluminium Pechiney Holdings Pty Ltd holds ML 7032 (formerly SBML 9) which extends from northeast of Aurukun to as far south as the Archer River. Opencut mining was planned, but the project has been in a care and maintenance phase since 1984. The mineable resource is approximately 300 Mt (White, 1991).

In 1971, Pacminex Pty Ltd calculated pisolitic bauxite resources for the area south and southeast of Vrilya Point as 3.6 Mt at a cutoff grade of 50% total Al_2O_3, 13.7 Mt at a cutoff of 45% total Al_2O_3, and 38.4 Mt at a cutoff of 40% total Al_2O_3 and <10% reactive silica. In 1982, resources were recalculated as 100 Mt grading 44 to 45% total Al_2O_3 and 7% reactive silica. This resource is made up of numerous, scattered, thin (average 1.4 m thick) deposits with significant boehmite in the upper portion of the profile. Physical beneficiation of the bauxite to produce a product with an acceptable reactive silica level is not currently economically viable.

Small residuals of aluminous laterite are exposed in cliffs beneath silica sand dunes on the northeast coastline of Turtle Head Island and along the coast from the Escape River southeast to about 1.5 km north of Logan Jack Creek. These deposits are thought to be a product of lateritisation of the Helby beds (Smart & others, 1980). The bauxite is a 0.3 to 5.0 m thick layer of hard, red pisolitic to nodular material and overlies a ferruginous nodular band, grading downwards into partly iron-stained sediments. The bauxite is too high in iron and silica to be exploited commercially. A white, low-iron variety occurs in cliff faces on Turtle Head Island and on the mainland from White Beach to Sharp Point and in the headwaters of creeks in the area. The silica content of this bauxite renders it unsuitable for alumina production but it may be suitable for use as refractory grade bauxite. The white bauxite occurs in low areas, below the permanent water table.

Enterprise Exploration Company inferred a resource of 280 Mt of bauxitic material (with <2 m overburden) on the mainland, with another 100 Mt deduced from the topography. The inferred resource on Turtle Head Island was 30 Mt with <2 m overburden and 30 Mt beneath sand dunes up to 91 m deep. The approximate average grade was reported to be 35 to 40 % total available alumina (7 to 10 % of which is the monohydrate variety) and 12 to 15 % total silica (7 to 10 % of which occurs as combined silicate). Altarama Search Pty Ltd inferred a resource of ~19 Mt with >40 % alumina, <10 % reactive silica, and >2 m mineable thickness. Comalco Aluminium estimated that SBML 5, which covered the Turtle Head Island and mainland deposits, contained an inferred resource of 230 Mt of red bauxite.

5.2.10 Kaolin

The distribution of kaolin deposits is shown on Figure 8.

5.2.10.1 Weipa. At Weipa, kaolin is mined for the production of premium quality coating clays. The kaolin occurs in the pallid zone of the laterite profile and is mined from areas from which the overlying bauxite has been removed. The deposits are discontinuous clay lenses approximately 2 to 3 km long, 300 m wide and 4.5 m in average thickness. They overlie a shallow quartz sand aquifer. The top and bottom contacts with sandstone and clayey sandstone are sharp.

Studies of the kaolin and the relationship between the claystones and sandstones of the Weipa beds indicate that the kaolin was laid down as a clay. The purity of the kaolin probably is the result of alterations which occurred during the formation of the laterite profile.

The crude kaolin ore contains 70 to 90 % kaolinite, 5 to 20 % quartz sand, 0.1 to 0.3 % hematite, 1.2 to 1.6 % anatase and 1 to 3 % muscovite. Accessory minerals include zircon, tourmaline, leucoxene, rutile, ilmenite, goethite, sphene, siderite, magnetite, apatite, monazite, andalusite, staurolite, spinel and halloysite (Schaap, 1990). The kaolin product comprises kaolinite plus a small amount of anatase.

The deposit contains proved and probable reserves of 17.8 Mt and a total resource of approximately 50 Mt.

Recently, extensive areas of kaolin have been found in the Pennefather River - Mapoon area, about 20 km north of the Weipa deposit (White, 1991).

5.2.10.2 Skardon River. Venture Exploration N.L. is investigating the mining potential of paper-coating grade kaolin deposits on its ML 6025 (formerly ML 5, Weipa) near the Skardon River. Reserves are estimated at 27 Mt of raw kaolinite, containing 15 to 50 % of <2 micron kaolin (White, 1991). The aluminium and iron contents are reportedly lower than in the Weipa deposits. There are about 8 Mt of shippable kaolin product (at an estimated average of 32 % of <2 micron kaolin). Capital costs are low and interests have been registered for purchasing the kaolin. Dredging is planned to produce 0.2 Mt/year as a slurry. In 1991, the Federal Government's Industry Research and Development Board awarded Venture Exploration a grant of $171 000 to assist in construction of a pilot processing plant. This pilot plant in Cairns is already producing high quality, refined kaolin. The company is currently seeking financing to allow establishment of the first stage of the mine by mid to late 1995. The mine is expected to have a 200 000 t/y production rate and an expected lifespan of 40 years (Cooper, 1993c).

5.2.11 Silica sand

Significant deposits of Quaternary dune sands occur along the east coast of Cape York Peninsula (Figure 9). Deposits at Cape Flattery and Shelburne Bay are suitable for glass manufacturing and foundry sand.

Figure 9

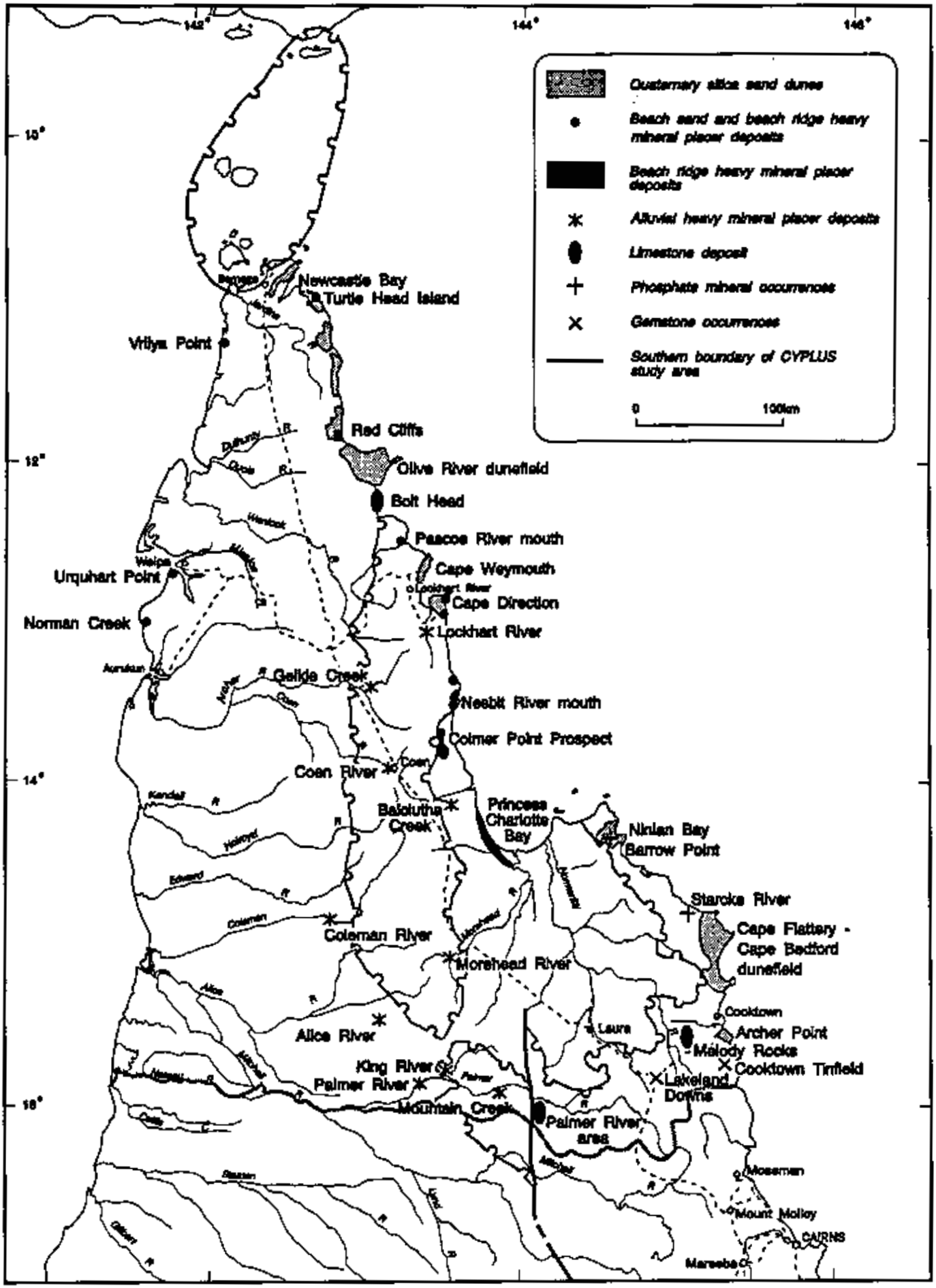

Figure 9: Distribution of silica sand, heavy mineral, limestone, phosphate, and gemstone deposits

5.2.11.1 Archer Point. Extensive deposits of white dune sand occur at Archer Point, south of Cooktown. The sands occupy a 4 km by 3 km area and form a thin veneer on sedimentary rocks of the Hodgkinson Formation. Martin (1980b) concluded that the fineness of the sand and the large variation in some size fractions render it unsuitable for use in glass making. The average grade is 97.8 % SiO_2, 0.7 % Fe_2O_3, 0.2 % Al_2O_3 and 0.21 % loss on ignition, making the sand chemically inferior to that at Cape Flattery.

5.2.11.2 Cape Flattery - Cape Bedford dunefield. The Cape Flattery - Cape Bedford dunefield extends from Cooktown north to Lookout Point. It is 55 km long by up to 22 km wide and covers an area of 580 km^2.

The dunefield occupies a low-lying coastal plain, 5 to 10 m above sea-level, and formed because of a local abundance of sand derived from Palaeozoic granites and Mesozoic sandstones and exposure to strong onshore winds. Quartz sand drifted north until trapped by the bedrock headlands of Cape Bedford, Cape Flattery and Lookout Point. Transgression of a rising sea in Pleistocene interglacial periods eroded frontal dunes and created a sand source by recycling the existing dunes (Cooper & Sawers, 1990).

The field consists predominantly of white, sharp-featured, active, transgressive parabolic and elongate parabolic dunes, and rounded degraded dunes stabilised by vegetation. The almost unidirectional southeasterly winds have resulted in dunes which are more than 7 km long and only 0.5 km wide. The apical sand mound can be up to 90 m above the surrounding sand plain. The active dunes consist predominantly of quartz sand; heavy mineral content ranges from a trace to about 0.75 % (mainly ilmenite).

Mining is currently carried out at the Cape Flattery Silica Mine, 60 km north of Cooktown, where Cape Flattery Silica Mines Pty Ltd has proved reserves of 200 Mt under mining lease (Cooper, 1993d); the potential resource in the area would be much greater. The optimum source of white silica sand is the bare apical mounds of the elongate parabolic dunes. The grain size distribution is particularly suitable for glass manufacture and foundry moulding. Cooper & Sawers (1990) gave a chemical analysis for export quality sand of 99.82 % SiO_2, 0.01 % Fe_2O_3, 0.05 % Al_2O_3, 0.02 % TiO_2, <0.01 % CaO, <0.01 % MgO and 0.10 % loss on ignition.

5.2.11.3 Ninian Bay area. Sand dunes on the western side of Ninian Bay represent a silica sand resource that would require beneficiation to produce a marketable product. The bulk of the sand averages >99.5 % SiO_2, but iron and titanium impurities exceed standards for glass manufacturing. There is an estimated 24 m depth of sand in the main dune area and 12 m in the low dunes. The area investigated is now within the Cape Melville National Park. An extensive area of vegetated dunes occurs to the south and southwest of Ninian Bay; these dunes have not been investigated.

5.2.11.4 Colmer Point. After processing, silica sand forming the palaeo-beach ridge system of the Colmer Point heavy minerals deposit may be suitable for use in glass making. Inferred resources are 192 Mt of contained silica (Cooper, 1993d).

5.2.11.5 Cape Direction to Cape Weymouth. Sand dunes in the Cape Direction and Cape Weymouth areas have not been investigated as potential sources of silica sand.

5.2.11.6 Olive River dunefield. The Olive River dunefield extends from the Olive River north to Shelburne Bay and inland for 15 km; it covers an area of 550 km^2 of a roughly triangular-shaped, low coastal plain. The dunefield is of Quaternary age and overlies Jurassic and Cretaceous quartzose rocks of the Carpentaria Basin. Theories on the genesis of the dunes differ from those for the Cape Flattery - Cape Bedford dunefield, and the Olive River dunes are thought to be much younger. Cape Grenville may have acted as an anchor point for the progradation of a sand barrier, with the resultant accumulation of the field (Cooper & Sawers, 1990).

The field is characterised by active parabolic and elongate parabolic dunes aligned parallel to the prevailing southeast winds and by older stabilised and lateritised dunes. The dunes consist almost entirely of quartz sand; heavy mineral content is 0.024 to 0.206 % (mainly ilmenite and zircon).

In the central and northern areas, active parabolic and elongate parabolic dunes, with numerous shallow deflation lakes and swamps, are all well developed on a relatively low interdune sandplain. The northeastern sector contains well vegetated, hummocky, degraded, older, stabilised and lateritised dunes, with a small area of white, active, elongate parabolic dunes which have been investigated as a source of silica sand. These dunes are over 80 m high, and have a central deflation corridor and interdune lakes. Conical Hill and Saddle Hill are about 1.5 km long and up to 250 m wide. Major dunes in the north and northwest include Round Point and White Point.

In 1967 and 1968, Metals Exploration N.L. delineated a potential resource of 6 Mt of high-grade sand with greater than 99 % SiO_2 to 12 m depth at Shelburne Bay. In 1973 to 1977, A.C.I. delineated more than 200 Mt of good quality glass making sand within 16 km of Round Point.

More recent activity centred around the Shelburne Bay silica sand project in the northern part of the field. A firm development proposal was formulated by the Shelburne Silica Joint Venture, comprising Shelburne Silica Pty Ltd and ASP Resources (Queensland) Pty Ltd (jointly owned by Toyo Menka Kaisha Ltd and Nippon Sheet Glass Company Ltd). Exploration on ML 5945 proved reserves of 8.76 Mt of high quality sand at Conical and Saddle Hills, where a more than 40 m thickness of white sand has been derived from aeolian reworking of well-developed podsolic A_2 horizons. There is 40 Mt of probable reserves covered by mining lease tenure. Inferred resources are 143 Mt (Cooper, 1993d).

The sand meets specifications for foundry moulding and glass manufacture. Cooper & Sawers (1990) gave a chemical analysis for Conical Hill sand of 99.80 % SiO_2, 0.001 % Fe_2O_3, 0.037 % Al_2O_3, 0.013 % TiO_2, 0.0001 % Cr_2O_3, <0.01 % CaO and <0.01 % K_2O. Grainsize range is similar to that of sand currently mined at Cape Flattery.

An opencut mine was planned with an expected capacity of up to 2.0 Mt/year, using Margaret Bay as a port site, but the project was deferred when Commonwealth Government action prevented the development on environmental grounds. The main deposits are protected by a Department of Minerals and Energy Restricted Area.

5.2.11.7 Shelburne Bay to Newcastle Bay. Extensive, shallow, windblown dunes of white sand extend inland for up to 8 km from Red Cliffs north to Newcastle Bay. Dunes in the Red Cliffs area were drilled by Altarama Search Pty Ltd in 1970 and 1971 but the company did not consider the sand to be sufficiently pure for use as silica sand.

Dunes in the Orford Bay - Orford Ness area are unlikely to be economic. Processing would be required to remove heavy minerals from the sand (White, 1991). The dunes are now within the Jardine River National Park.

5.2.11.8 Newcastle Bay to Escape River. High quality sand suitable for glass manufacture overlies bauxitic laterite along the coast from Newcastle Bay to the Escape River and on Turtle Head Island. The dunes on Turtle Head Island are up to 91 m deep. Comalco Aluminium Ltd delineated a probable resource of >30 Mt of high purity sand. Chemical analyses of samples gave 99.70 to 99.78 % SiO_2, 0.011 to 0.014 % Fe_2O_3, 0.04 to 0.06 % Al_2O_3, 0.026 to 0.064 % TiO_2, <0.01 % CaO, <0.01 % MgO, <0.001 % Cr_2O_3 and 0.10 to 0.15 % loss on ignition.

5.2.11.9 Skardon River. Silica sand could be produced as a by-product during processing of the Skardon River kaolin.

5.2.12 Heavy minerals

Heavy mineral sands occur extensively throughout Cape York Peninsula (Figure 9) but few deposits are of economic interest. The main deposit types are beach and beach ridge placer deposits, dune placer deposits and alluvial placer deposits. The dominant mineral present is ilmenite, but rutile, zircon and leucoxene also occur; tantalite has been reported from some alluvial deposits. Many of the deposits contain significant proportions of rare earth minerals such as monazite and xenotime. The primary source of the heavy minerals is the Proterozoic metamorphic rocks and the Palaeozoic granitic rocks of the Coen and Yambo Inliers and Hodgkinson Province and reworked detrital grains from Mesozoic and Cainozoic sedimentary sequences. The most significant deposit is the palaeo-beach ridge placer deposit at Colmer Point.

5.2.12.1 West coast of Cape York Peninsula. Beach sands along the western coast of Cape York Peninsula have no potential as heavy mineral deposits, but some beach ridge systems have some potential.

A sizeable deposit of moderately high grade black sand occurs in **beach ridges** near Urquhart Point, opposite Weipa. Associated Minerals Consolidated Ltd (a wholly owned subsidiary of Renison Ltd) currently holds ML 6023 over the deposit. The deposit is unusual in that up to 80% of the concentrates consist of rutile and zircon, rather than ilmenite.

Another deposit with rutile and zircon as the main constituents occurs at the mouth of Norman Creek, but is subeconomic.

Heavy minerals also occur in **coastal sands** at Vrilya Point (White, 1991).

Streams draining west into the Gulf of Carpentaria commonly carry subeconomic concentrations of heavy minerals (mainly ilmenite, with some zircon, rutile, leucoxene, monazite and xenotime). Total heavy minerals generally constitute <1% of the alluvium and volumes of material available are generally too low for a viable mining operation. River systems known to carry heavy minerals include the Palmer, Red, Mitchell, King, Coleman, Alice and Coen.

5.2.12.2 East coast of Cape York Peninsula. **Beach sands** on Turtle Head Island contain 5 to 10 % heavy minerals (zircon, rutile, ilmenite and garnet) but deposits are too small to be economic. Drilling samples collected by A.O. (Australia) Pty Ltd returned >0.5 % heavy mineral concentrates. **Sand dunes** at Chandoogoo Point also contained >0.5 % heavy minerals.

Thin, discontinuous surface concentrations of heavy minerals occur on present **beaches** on the east coast of the Peninsula, especially between Princess Charlotte Bay and Orford Bay.

Low **beach ridges** in the Princess Charlotte Bay area have generally low heavy mineral contents. Although auger samples have contained up to 3.1% heavy minerals, the minerals are invariably magnetite and ilmenite.

A number of thin, discontinuous seams occur on narrow **beaches** between Cape Sidmouth and Cape Direction and near the mouths of the Nesbit and Pascoe Rivers. The concentrates contain >90% ilmenite, with minor zircon, rutile, magnetite and monazite. A sandbar extending north from the Nesbit River mouth contains concentrates that are dominantly ilmenite and are extremely poor in rutile and zircon.

Thin, discontinuous surface seams of heavy minerals occur on **beaches** north of Shelburne Bay, particularly in the Red Cliffs area. The sands contain up to 0.43% heavy minerals (mainly ilmenite, rutile and zircon). Drilling has indicated a total potential resource of only 500 m^3 of sand.

A Pleistocene, quartzose **sand dune** system near Colmer Point is currently being investigated as a heavy mineral resource. The main dune system extends north and south of the Rocky River and is 20 km long, up to 3 km wide, and up to 100 m above sea level. A second large dune system extends north of the Nesbit River. The dunes may be **beach ridge deposits.**

The dunes were investigated by Alberta Mines N.L. as a potential source of silica sand. However, Alberta Mines concluded that the heavy mineral content was too high for a silica sand operation without incorporating a processing stage.

Peko Wallsend Operations Ltd (in joint venture with Lake Libby Pty Ltd and Arkara Minerals Pty Ltd) is currently investigating the dune systems under EPM's 5767, 5772 and 5830. The dunes contain low-grade concentrations of ilmenite, rutile, zircon and leucoxene.

Generally, the transgressive **dune systems of silica sand** on the east coast of the Peninsula contain only minor proportions of heavy minerals. Heavy mineral content ranges from a trace to 0.75% at Cape Flattery and 0.02 to 0.2% at Shelburne Bay (Cooper & Sawers, 1990). The main minerals present are ilmenite and zircon.

Streams draining into Princess Charlotte Bay, such as Balclutha Creek, and the Stewart, Morehead, Laura, Kennedy and Normanby Rivers carry ilmenite, rutile, zircon, monazite and xenotime. Alluvial sands of other streams draining east of the main divide, such as Lockhart River, are known to contain subeconomic concentrations of ilmenite, monazite, zircon and rutile.

5.2.13 Limestone

5.2.13.1 Bolt Head. Limestone crops out at Bolt Head in the Temple Bay area (Figure 9). It is coarsely crystalline and schistose, has a stratigraphic thickness of at least 100 m, and is part of the Sefton Metamorphics. It is cut by calcite and quartz veins, thereby adversely affecting the overall grade. Broken Hill Pty Company Ltd estimated that there is only about 25 000 t of limestone readily available. Hand-picked material, free of quartz veins, assayed 53.0 % CaO, 1.2 % MgO and 2.4 % SiO_2. It is unlikely that the total resource would be more than 1 Mt.

5.2.13.2 Melody Rocks. Queensland Metals Corporation Ltd currently hold MDL 5 over the Melody Rocks limestone deposit near Kings Plains. The limestone occurs as lenses in the Hodgkinson Formation in a 2700 m by 700 m area, with vertical exposures of up to 120 m. Eight bodies are of potential economic interest and five are of major significance. The limestone is light grey, fine-grained and homogeneous. The five major lenses comprise approximately 900 000 t/vertical m of limestone at 55 % CaO, <1.0 % SiO_2, <0.4 % MgO, <0.2 % Fe_2O_3 and <0.4 % Al_2O_3. Indicated resources are >100 Mt of high to chemical grade limestone. The company has carried out feasibility studies on setting up a cement clinker plant at Archer Point. The high quality of the limestone would allow it to be marketed, not only for cement manufacture, but also for the chemical and mineral processing industries or agriculture.

5.2.13.3 Palmer River area. Large resources of limestone (~1 500 Mt) occur in a belt in the Chillagoe Formation extending between the Mitchell and Palmer Rivers (Krosch, 1990). This belt extends northwards beyond the Palmer River but is difficult to access.

The limestone normally is light to dark grey, massive, and recrystallised in the vicinity of granite intrusives. Chert, sediments and basalt are interbedded with the limestone.

5.2.14 Phosphate

Phosphate minerals are associated with thinly bedded black chert and shale sequences of the Hodgkinson Formation in the Starcke River and Barrow Point areas, north of Cooktown (Figure 9). The rocks are intensely silicified and veined; ferruginous gossans are developed.

The cherts contain small, white lenses which contain apatite and may represent flattened phosphate pellets and balls which formed during deposition of the chert-black shale sequences. These lenses rarely constitute more than 25 % of the total rock and it is unlikely that the rock as a whole would grade more than 5 % P_2O_5. Wavellite, strengite, variscite and gorceixite occur on joints and weathered surfaces and as veins. The deposits are not economic.

5.2.15 Gemstones

Zircon, garnet and sapphire occur in the weathering products of basaltic pyroclastic deposits at Mount McLean, Hoskin's Vent and Tom's Hollow, in the Lakeland Downs area (Figure 9). Zircon, garnet and rare sapphire occur in the drainage system within Bull Hollow (Domagala & others, 1993).

Diamonds have been recovered from the East and West Normanby Rivers and Little Palmer River during alluvial gold mining operations, as well as from the Laura River drainage system in the Lakeland Downs area. Diamond indicator minerals have been found at Tom's Hollow and Bull Hollow. Extensive company exploration has failed to find the source of the diamonds.

Minor sapphires have been recovered from time to time during alluvial tin mining operations in the Cooktown Tinfield and from Campbell and Spear Creeks, which are tributaries of the Palmer River.

5.2.16 Coal

In Cape York Peninsula, coal is known to occur in Carboniferous, Permian and Mesozoic sediments (Figure 10). In recent years, several companies have been active in prospecting for coal around the margins of the Laura Basin and the eastern margin of the Carpentaria Basin. The general philosophy has been to examine the possibility of coal in basal Jurassic fluviatile sediments, or in possible subsurface Permian sediments beneath the Mesozoic sequence.

5.2.16.1 Pascoe River area. Morton (1924) reported that the presence of coal in the Pascoe River valley had been known to prospectors for at least 30 years. He investigated outcrops along the Pascoe River and Hamilton Creek and found that they consist mainly of carbonaceous shale with coal bands up to several centimetres thick. He described one outcrop, near the Hamilton Creek junction, as 3 m of "highly metamorphosed carbonaceous strata, including 50% of stony bands". The original carbonaceous material is now graphitic. A sample from a 50 to 100 mm thick coal seam gave the following analysis: 1.3% moisture, 37.9% volatiles, 51.3% fixed carbon, 9.5% ash.

Several coal seams occur in the **Carboniferous** Pascoe River beds, both in outcrop and in bore holes, but the seams are generally thin (< 150 mm thick) and are uniformly of very poor quality. They are steeply dipping and are disrupted by shearing parallel to bedding planes and by large-scale normal and wrench faulting. An estimate of reserves (of the order of 1.8 Mt) suggested that the coal is uneconomic.

Morton (1924) reported that coal also occurs in a thin shale bed near the base of the **Mesozoic** sandstone overlying the Pascoe River beds near the confluence of Canoe Creek and the Pascoe River. A sample gave the following analysis: 0.6% moisture, 34.1% volatiles, 42.6% fixed carbon, 22.7% ash. Drilling of the Mesozoic sequence indicated that only rare, very thin (< 300 mm) lignite coal seams are present and that the Mesozoic rocks have no coal-producing potential.

5.2.16.2 Olive River Basin. **Permian** coal seams occur over a restricted area in the Olive River Basin (Wells, 1989a). The seams are at 98 to 364 m depth and are of coking quality. The known areal extent is small and the sequence is probably affected by faults. Exploratory drilling to date has not delineated any economic deposits. Coal has also been intersected in the Mesozoic Garraway Sandstone in this area.

Figure 10

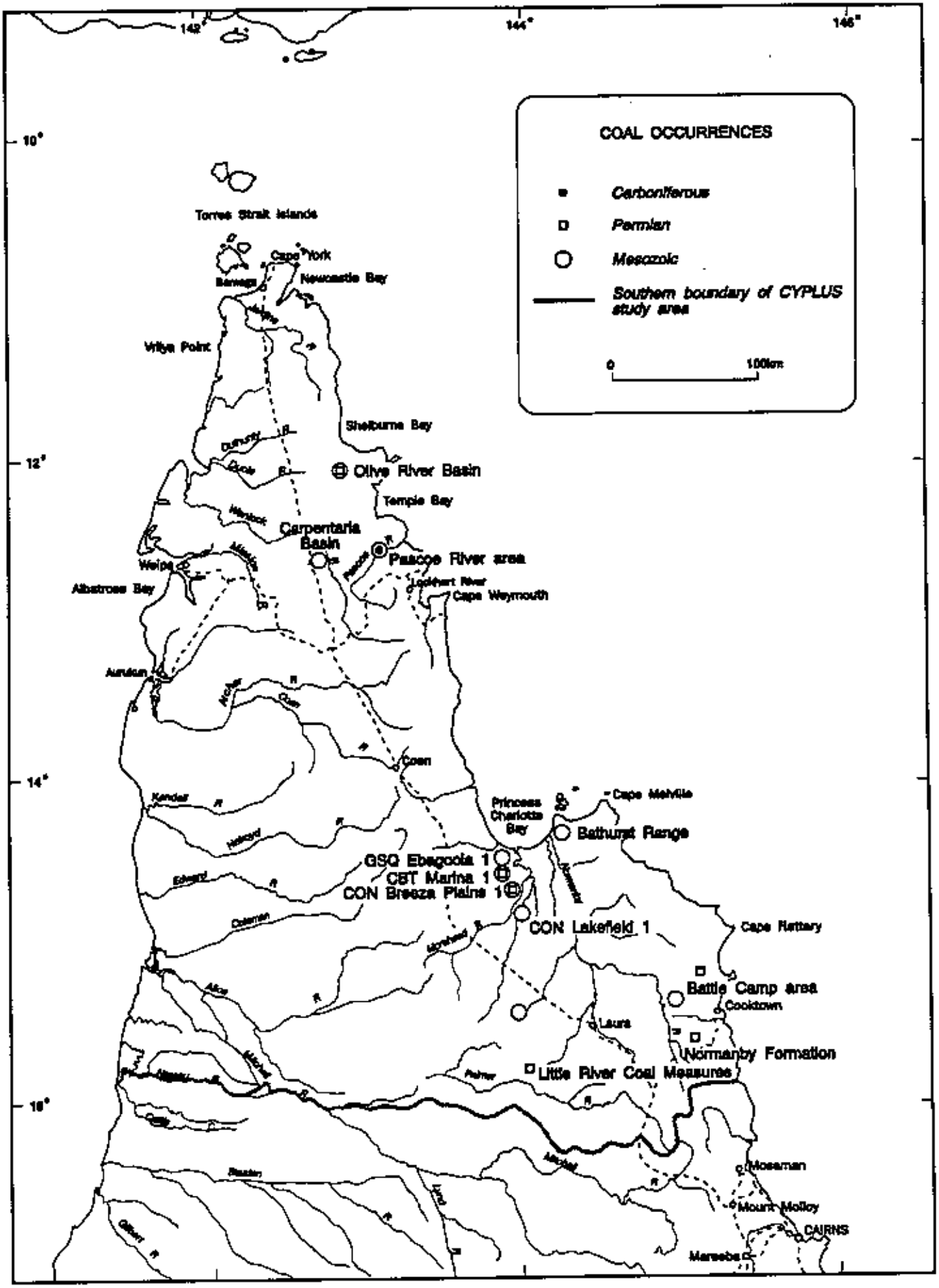

Figure 10: Coal occurrences, Cape York Peninsula

5.2.16.3 Little River Coal Measures. Coal was first discovered along the Little Kennedy River in 1872 by Norman Taylor, the geologist accompanying Hann's expedition. The proximity of the coal to the Palmer Goldfield and the announcement of a projected rail link between Laura and Palmerville led to intensive prospecting in 1881.

Jack (1882) reported on the results of shaft sinking and described several outcrops along the river and its tributaries. The coal is weathered in outcrop but reportedly improved at depth, although still containing a high proportion of clay. The seams occur in the **Permian** Little River Coal Measures and are up to 6 m thick, but are steeply dipping and strongly deformed, faulted and slickensided. Two samples collected by Jack (1882) contained 0.919% and 2.763% moisture, 9.388% and 26.197% volatile hydrocarbons, 58.606% and 62.998% fixed carbon, and 31.087% and 8.042% ash. The coal is of poor quality (Carr, 1975b; Wells, 1989b).

Rands (1893) also described prospecting operations in the area. The analyses of three coal samples were: 1.60 to 1.68% moisture, 9.41 to 12.94% volatile hydrocarbons, 76.10 to 82.38% fixed carbon, 0.08 to 0.44% sulphur and 5.94 to 10.78% ash. Rands concluded that the coal is of very inferior quality and that the steep dip of the seams would make them uneconomical to mine.

5.2.16.4 Normanby Formation. The **Permian** Normanby Formation contains at least 30 m of shaly coal in outcrops about 1.6 km northeast of the Brothers. The coal is of poor quality and has a high ash yield (Carr, 1975b; Wells, 1989b).

Jack (1879a) reported the discovery of coal in the Little Oakey Creek - Deep Creek area. A shaft was sunk to 6 m depth on a 460 mm thick seam of dark carbonaceous clay with coal streaks and a 250 mm seam of impure argillaceous coal. Jack found numerous coal seams, some of very good quality, between Oakey Creek and the Normanby Range; the thickest seam was only 200 mm. Jack noted that the deposits are older than Mesozoic sediments capping hills in the area.

Jack (1879b) reported that the coal-bearing sediments extend over a 9.6 km long by 2.4 km wide area. Some good quality coal was found, but only in seams less than 75 mm thick.

5.2.16.5 Permian sediments beneath the Laura Basin. Coal traces and carbonaceous material have been recorded in Permian strata beneath the Laura Basin sediments in petroleum exploration wells CBT Marina 1 and CON Breeza Plains 1 (Carr, 1975b; Wells, 1989b). Coal exploration has also led to the discovery of thin coal bands in Permian sediments beneath the basin.

5.2.16.6 Laura Basin. Carbonaceous shale and very thin coal seams (generally less than 300 mm thick) are common in the lower part of the **Mesozoic** Dalrymple Sandstone, particularly the basal 30 m of the formation.

Jack (1879b) noted a 200 mm thick shale section with thin coal bands near the base of the formation on the northern side of the Endeavour River. Thin coaly beds and laminae occur at about 30 m above sea level on the western side of a hill west of Cape Flattery (Lucas & de Keyser, 1965b). The ash content of coal from the Dalrymple Sandstone has been recorded as 8 to 26% (Dunstan, 1913).

Coal occurrences have been known in the Battle Camp Siding area since the 1880's. They attracted interest because of their proximity to the Cooktown - Laura railway. All of the seams are within the Dalrymple Sandstone. Jack (1887) reported that shafts had been excavated on coal seams to 0.46 m thick in the Welcome Creek area. Two samples assayed 8.25% and 7.16% moisture, 30.42% and 20.96% volatile hydrocarbons, 42.31% and 35.35% fixed carbon, and 19.02% and 36.53% ash.

Jack (1895) reported that Christie's shaft (105 m deep) at the "38 Mile" intersected a 250 mm thick coal seam which assayed 0.95% moisture, 19.77% volatile hydrocarbons and sulphur, 66.88% fixed carbon, and 12.40% ash. Other thin coal seams (to 75 mm thick) were also intersected in the shaft. An adit excavated at Stack's Creek exposed 250 mm of good quality, clean coal which was used on the Laura locomotive with satisfactory results.

Jackson (1902) reported assay results for four samples from two coal seams in Christie's adit. The samples gave 0.80 to 1.645% moisture, 17.89 to 20.185% volatile hydrocarbons, 33.95 to 42.94% fixed carbon, and 36.34 to 46.51% ash. Jackson concluded that the coal contained too much ash and was poor in quality. Ball (1909) has also reviewed the coal deposits in this area.

Traces of coal have been found in Mesozoic sediments in a number of petroleum exploration holes in the area. Jurassic coal crops out in the area northeast of Laura, but by far the most important discovery to date has been an underground, coking coal resource at Bathurst Range.

From 1978 to 1986, Utah Development Company delineated an underground coking coal resource in Jurassic sediments at Bathurst Range. A number of seams occur at up to 400 m depth over a 140 km^2 area. Exploration has concentrated on one major seam which is up to 2 m thick and averages 1.6 m. Resources have been variously quoted as 15 Mt (Miezitis & Bain, 1991), 255 Mt (White, 1991), and 157 Mt (Queensland Department of Minerals and Energy, 1993). The deposit is currently covered by EPC 463, which was held by BHP-Australia Coal Ltd but has recently been sold to Bathust Coal and Power Ltd. The coal is a medium to low volatile, bituminous coking coal with a moderately high sulphur content (Hawkins & Williams, 1990) and can be washed to produce a low ash, high swelling product with good yield (Doyle & others, 1986). Bathurst Coal and Power Ltd have commenced a feasibilty study to produce a mine plan for production and export of high grade coking coal by the end of 1995 (North Queensland Register, 23rd June 1994).

5.2.17 Petroleum

The results of petroleum exploration in the CYPLUS area have been summarised by Denaro and Shield (1993). There is potential for petroleum to occur in the Laura and Carpentaria Basins, both of which are underexplored.

5.2.17.1 Laura Basin. Only five deep wells have been drilled in the basin thus far (Figure 11); all had hydrocarbon shows. Several 3 m coal seams were logged in the Dalrymple Sandstone in GSQ Ebagoola 1 and it is this unit (0.82 to 12.90 mass % total organic carbon) which is considered to be the most likely hydrocarbon source. The overlying Gilbert River Formation is more variable with regards to organic carbon and results range from 0.40 to 3.35 mass % (Hawkins & Williams, 1990). The Dalrymple

Figure 11

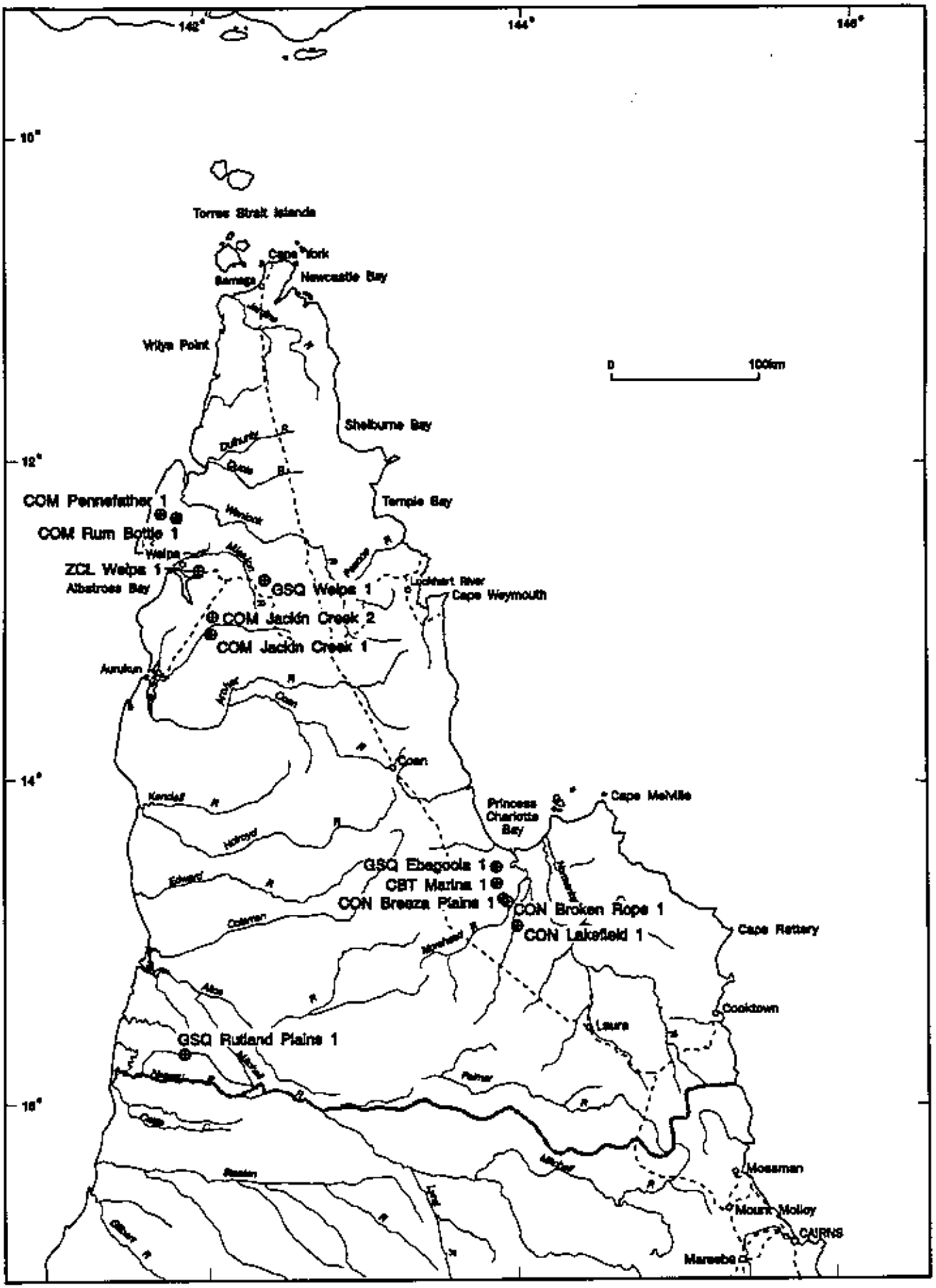

Figure 11: Petroleum exploration wells and Geological Survey of Queensland stratigraphic drillholes, Cape York Peninsula

Sandstone and Gilbert River Formation are dominated by a mixture of gas-prone (Type III) and oil-prone (Type II) vitrinite macerals.

The Dalrymple Sandstone is mature for hydrocarbon generation (0.7 % Rv) in CBT Marina 1, CON Breeza Plains 1, CON Lakefield 1 and GSQ Ebagoola 1 (Hawkins & Williams, 1990).

The undifferentiated Permian sediments intersected in these wells display a low total organic carbon content and gas-prone (Type III) vitrinite is the dominant organic matter type. However, only 90 metres have been drilled thus far, and the unit in GSQ Ebagoola 1 is post mature for hydrocarbon generation.

The Dalrymple Sandstone and Gilbert River Formation have facies-controlled stratigraphic plays as fluviatile sandstone beds. The Dalrymple Sandstone has porosity (7 to 22 %) and horizontal permeability (0.36 to 189 mD) values that are slightly better than those for the Gilbert River Formation (6 to 18 % and 1.3 to 106 mD, respectively). However, both units are suitable reservoirs. An excellent seal is formed by the mudstones and siltstones of the Rolling Downs Group. Mudstone beds in the Dalrymple Sandstone and Gilbert River Formation may result in a local seal but the lateral continuity of these beds is unknown.

Flushing of reservoir units by meteoric groundwater downgrades the hydrocarbon prospectivity of the basin. The reservoir units that are considered to be prospective for hydrocarbons are the same units that are considered to be prospective for groundwater. Salt water was recovered from some water bores (the Fairview bores). Therefore, it may be possible that isolated pockets of hydrocarbons have escaped the extensive flushing that has occurred throughout the reservoir units. It is possible that flushing of this magnitude may have been avoided in fault-controlled traps such as those associated with the Palmerville Fault Zone, or anticlinal traps with a vertical closure greater than 70 m (Ranneft, 1968). As the basin has not been deeply folded, it is unlikely that many stratigraphic traps have attained this amount of vertical closure.

Other hydrocarbon play types to be considered are the Permian and possible Triassic sediments underlying the basin, and trapped half-graben structures on the western side of the basin. Only the upper 90 metres has been drilled and contains suitable sandstone and tuffaceous reservoir beds which are post mature for hydrocarbon generation. It is possible that a potential source rock underlies this sequence. A major problem, as with all Queensland Permian basins, is finding a regional seal that has not been eroded during Triassic uplift and erosion.

5.2.17.2 Carpentaria Basin. The Carpentaria Basin is buried to a sufficient depth to be considered marginally mature for the generation of hydrocarbons. In the case of one recently drilled petroleum well (COM Jackin Creek 1), all sediments below 150 m were considered sufficiently mature for the generation of oil (McConachie and others, 1990). Although mature, the Jurassic Garraway/Helby beds and Gilbert River Formation are considered to be generally poor source rocks due to their lack of organic content. The carbonaceous beds and thin coal seams that occur in these units appear to be able to generate only subeconomic localised quantities of hydrocarbons. The overlying Rolling Downs Group has not been buried to sufficient depth to reach maturity for hydrocarbon generation.

The stratigraphic units with the highest prospectivity must be the unknown sequences lying in seismically-resolved grabens underlying the Carpentaria Basin. One such structure, the Olive River Graben has been fully investigated and evaluated. The study was warranted following the discovery of coal-bearing Permian sediments within the graben. Late Permian sandstones and siltstones containing coal stringers were deposited in a high sinuosity depositional environment. A seismic survey carried out in 1989 revealed that the sediments have not been buried to a sufficient depth to have generated oil.

The search continues for these graben structures in deeper areas of the basin such as the Weipa, Western Gulf and Staaten sub-basins. The depocentre of the entire basin lies offshore in the Western Gulf sub-basin and grabens in this region must be considered to be the most prospective.

High quality reservoir beds are abundant within the basin - both the Garraway/Helby beds and the Gilbert River Formation have laterally continuous sandstone beds with low clay contents. The Gilbert River Formation is the lowest unit to cover the entire basin, and must be considered as the primary reservoir target.

Porosity and permeability measurements obtained from GSQ Weipa 1 indicate very good reservoirs - 12.9 to 25 % porosity and 265 to 8000 mD permeability for the Gilbert River Formation, and 19.1 to 23.2 % porosity and 648 to 1003 mD permeability for the Garraway beds (Derrington, 1988). A negative factor to be considered is that both units have been flushed by groundwater.

The Permian sediments in the grabens have a high proportion of sandstone. However, not enough is known about their content to fully judge the quality of these reservoirs. A conglomeratic bed underlying these sandstones occurs in the Olive River Graben but its regional extent is unknown.

The Rolling Downs Group forms an excellent regional seal. Facies-controlled localised seals may exist within the Jurassic sandstone units. A seal at the top of the Permian sedimentary sequence, occurring in conjunction with coals and fine-grained carbonaceous beds, has not been fully evaluated.

Jurassic stratigraphic traps of anticlinal drape over basement highs have, from drilling thus far, failed to attain enough vertical closure to avoid flushing by groundwater. Pinch-out plays of Garraway/Helby beds against basement highs are yet to be fully evaluated. However, flushing of this unit has been significant and a reasonable vertical closure must be found. Faulting in the basin has been too mild to produce adequate traps.

The Permian contains good source and seal units. Underlying, or possibly interbedded with these units, are potential reservoir beds. It is possible that some graben features have been exposed and eroded during Triassic uplift. However, it appears that, in the case of the Olive River Graben, coal occurs at the top of the Permian (a feature that is easily identifiable on deep seismic). These grabens become mature for hydrocarbon generation only in the depocentres of the major sub-basins and must be further evaluated by drilling.

Therefore, the most prospective regions for hydrocarbon exploration exist in the depocentres of the Weipa, Western Gulf and Staaten sub-basins.

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APPENDIX 1: EXPLANATORY NOTES FOR CYPLUS MINERAL OCCURRENCE DATA

1.1 Introduction

For the purposes of mineral occurrence data collection by the Geological Survey of Queensland, the term "mineral" is restricted to metallic minerals, to potentially economic concentrations of non-metallic minerals, and to non-metallic mineral occurrences which may be of interest to exploration geologists. Coal, petroleum, oil shale, groundwater, and construction materials are not included in the mineral occurrence data base.

1.2 Information sources and reliability

Data are collected from office literature studies and field inspections. Literature reviewed includes the following:

- Department of Mines Annual Reports; Queensland Government Mining Journals; reports on exploration carried out under Authority to Prospect, Exploration Permit, Mineral Development Licence and Mining Lease tenure (Company Report series); lease plans, files and reports;
- Geological Survey of Queensland publications;
- Unpublished reports in Geological Survey of Queensland commodity files;
- Australian Geological Survey Organisation (Bureau of Mineral Resources) publications;
- Aerial Geological and Geophysical Survey of Northern Australia Reports;
- Published papers in technical journals;
- University theses;
- Stock exchange reports; and
- Company prospectuses and annual reports.

Most of the information from the above sources is considered reliable, though often incomplete. Reports written around the turn of the century provide very little detailed information about host rock and ore geology.

Production figures for smaller mines and mines worked prior to 1900 are considered to have low reliability. Because of incomplete reporting, these production figures are more likely to be under- than over-estimated. Company reports for areas currently held under Exploration Permit, Mineral Development Licence and Mining Lease tenure are confidential at this stage.

The following sections explain the types of information contained in the database and define the terminology used.

1.3 Name(s)

The name of a mineral occurrence is usually an historical mine name, lease name or company prospect name; preference is given to the most well known or latest name. Alternative names are shown in brackets. The term "Unnamed" indicates that the occurrence has no known name.

1.4 Commodities

Wherever possible, commodities are listed in order of their monetary value at the time of mining; this may differ from their order of abundance. The order of abundance is used if production figures are not available or if there has been no production.

1.5 Latitude and longitude

The locations of individual occurrences are given in terms of their latitude and longitude. These have been obtained by conversion of six digit easting and seven digit northing Australian Map Grid references, which were allocated to each mineral occurrence during data compilation and field inspection. AMG grid references were calculated as accurately as possible; the accuracy is dependent upon the scale and accuracy of available maps and the certainty with which the mineral occurrence could be located on maps and/or airphotos by the data recorder. A Garmin GPS100 satellite navigation instrument was used to obtain co-ordinates for many of the mines. These co-ordinates were referenced back to topographic maps in the field to check their accuracy. AMG grid references were generally recorded to an accuracy of $\pm$ 100 m.

1.6 Recorded by/date

The initials of the recorder of the data and the date of the most recent update (usually the date of a field inspection) are given. Dates are entered in the format "D/M/Y", for example "02/01/89". Initials refer to the following present and past officers of the Queensland Department of Minerals and Energy:

DAM	D Morwood
DLG	D Genn
FJB	F Bruvel
JSD	J Dugdale
JSL	J Lam
LGC	L Culpeper
PDG	P Garrad
PEB	P Burrows
TJD	T Denaro

1.7 Status

This field indicates whether the deposit is an operating or abandoned mine, a prospect or a mineral occurrence.

Operating mine - a mine which is currently being worked.

Abandoned mine - a mine which has been worked in the past but is not being currently worked.

Mineral occurrence - a locality containing visible mineralisation or significant assay results.

Prospect - a locality at which mineral exploration has indicated significant mineralisation. This mineralisation may not be visible at the surface; thus, a certain amount of subjective judgement is involved in differentiating between mineral occurrences and prospects.

1.8 Details of production

The production periods and total previous production (or estimated production where data are incomplete) of abandoned and operating mines are recorded. Chemical symbols are used for commodities when recording the production of metals; mineral abbreviations are used if it is known or likely that production figures refer to specific mineral concentrates; symbols and codes are explained in Table 1.2.

1.9 Resources and reserves

Ore resources and reserves are given in terms of category, tonnage, grade, cut-off grade, and reference, in accordance with the Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves (Australasian Institute of Mining and Metallurgy, 1989).

1.10 Geological setting

The names of the geological province/basin, stratigraphic unit, and rock type of the host rock are recorded under this heading. The main geological provinces/basins in Queensland are shown in Figure 1.1. Stratigraphic units are based on the most recent mapping by the Department of Minerals and Energy and the Australian Geological Survey Organisation.

1.11 Deposit form

This field gives the form or shape of the mineral deposit.

Stratabound refers to any ore body, concordant or discordant, which is restricted to a particular part of the stratigraphic column. Stratabound deposits which are themselves stratified are considered to be **stratiform.** **Veins** are tabular or sheet-like masses of minerals occupying a fracture or set of fractures in the enclosing rock. **Pipes** are elongate, cylindrical, discordant deposits. Systems of cross-cutting veins constitute **stockwork** deposits. **Lenticular** ore bodies are lens-shaped, concordant or discordant deposits. **Irregular** ore bodies have no definite form.

Disseminated deposits include those in which ore minerals are disseminated throughout the host rock, and those in which ore occurs as films on joint planes, as gash fillings, and as micro-veinlets. **Intrusive contact** ore bodies are mainly associated with intrusive rocks; they include **skarn** deposits which result from contact metamorphism and metasomatism. **Placer** deposits are mechanical accumulations of high density minerals in alluvial (stream), wave-formed (beach) or wind-formed sediments. **Residual** deposits are concentrations of minerals resulting from the decomposition and removal of the non-ore material of the host rock.

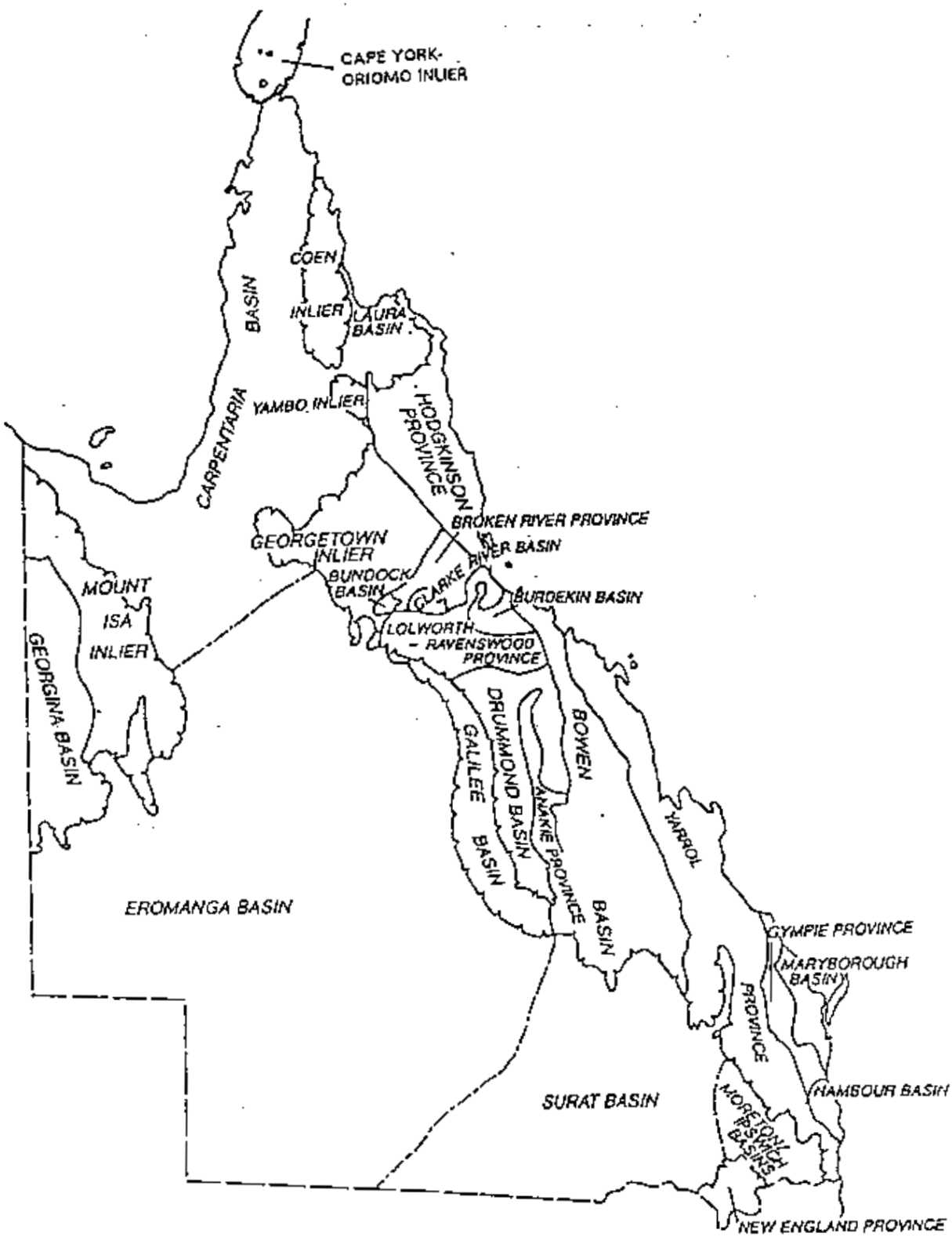

Figure 1.1: Main geological provinces of Queensland

1.12 Deposit dimensions and orientation

Dimensions, strike and dip of the ore body, where known, are given in this field. Trends and approximate strike directions are indicated using a '~' sign before the bearing. Strike directions, unless otherwise indicated, are with respect to magnetic north.

1.13 Ore mineralogy

The primary and secondary minerals which constitute the ore are listed according to their **volumetric abundance, irrespective of economic implications**. Other minerals, usually non-metallic minerals, occurring in close association with the ore are listed under "gangue" in their order of abundance. Generally, these minerals include silicates, carbonates, phosphates, sulphates and halides.

1.14 Ore genesis

This field provides an overall description of the type of ore deposit and its geological setting.

1.15 References

Published and unpublished references for each mineral occurrence are listed in the last field. The following abbreviations are used:

AGGSNA	Aerial Geological and Geophysical Survey of Northern Australia Report
AP	Authority to Prospect
ARDM	Annual Report of the Department of Mines
C	Confidential
CR	Company Report No.
EPM	Exploration Permit (Minerals)
MDL	Mineral Development Licence
ML	Mining Lease
MLA	Mining Lease Application File No.
QGMJ	Queensland Government Mining Journal

Company reports are held by the Queensland Department of Minerals and Energy. Full bibliographies for the data are contained in the mineral occurrence reports for individual sheet areas.

1.16 Bibliography

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Table 1.1 : Database fields definition

Field No.	Field Name	Definition	Width	Output width	Type
1	LABEL_NO	Label number	5	5	I
2	NAME	Name of mine or prospect	80	80	C
3	MINESTAT	Status of occurrence	40	40	C
4	COMMODITYS	List of mineral commodities	40	50	C
5	PRODPERIOD	Recorded period of production	40	40	C
6	TOTALPRODO	Total recorded ore production	20	20	C
7	TOTALPRODM	Total recorded metal production	40	40	C
8	RESERVESOD	Published resources and reserves	225	200	C
9	PROVBASIN	Geological province or basin	30	30	C
10	FORMATION	Geological formation	65	65	C
11	HOSTROCK	Host rock type of mineralisation	70	70	C
12	DIMORIENT	Dimensions and orientation of mineral deposit	165	165	C
13	DEPFORM	Form or shape of mineral deposit	60	60	C
14	MINPRIM	Primary ore minerals	125	125	C
15	MINSECD	Secondary ore minerals	90	90	C
16	GANGUE	Gangue minerals	110	110	C
17	OREGENESIS	Description of type of ore deposit and geological setting	206	200	C
18	REFERENCES	Bibliography list	254	200	C
19	RECORDBY	Initials of data recorder	7	7	C
20	DATE	Date of field inspection or data compilation	8	8	C

Table 1.2: Chemical symbols used for elements and abbreviations used for mineral names

Symbol/abbreviation	Element/mineral
Ag	Silver
Al_2O_3	Alumina
Au	Gold
BX	Bauxite
CST	Cassiterite
Cu	Copper
KAO	Kaolin
MOLY	Molybdenite
Sb	Antimony
SCHE	Scheelite
SiO_2	Silica
Sn	Tin
STIB	Stibnite
W	Tungsten
WOLF	Wolframite