GINGIN

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

URBAN GEOLOGY OF THE GINGIN SHEET

The aim of this urban geology survey is to provide information for planners and designers concerned with aspects of urban, rural, industrial, transport or raw material and water supply development. The intention is to point out geological factors which may affect planning, on a broad rather than a specific basis. Detailed site investigations will still be required but it is hoped that this map sheet will provide a useful framework for such further work.

This map covers an area of 659 km^2 and is underlain by Cretaceous rocks in the east and Cainozoic rocks elsewhere. The area is part of the Perth Basin.

The only town is Gingin with a population of approximately 350 in 1971. Probably a similar number constitutes the rural agricultural population of the Sheet area. Roughly 40 per cent of the land surface has been cleared for agriculture (sheep and cattle raising or fattening and minor vineyards near Gingin). The remaining 60 per cent is either uncleared or has regenerated from previously cleared land.

Detailed geological re-mapping was carried out in 1975 by R.H. Archer, R.M. Hocking and G.W. Marcos of the Geological Survey of Western Australia. Extensive field traverses were utilised on a base-map scale of 1:25 000, using 1972 air photography for minor extrapolation. Additional data on engineering geology, mineral resources, hydrology and environmental geology were provided by the relevant sections of the Geological Survey.

STRATIGRAPHY

Sedimentary rocks of Holocene, Pleistocene and Cretaceous age crop out within the mapped area while older Mesozoic and Palaeozoic rocks are known from borehole information to occur at depth.

MESOZOIC

The Lower Cretaceous Leederville Formation is exposed in small scattered outcrops along the eroded edge of the Gingin Scarp. It is a continental to shallow marine sequence of sandstone with minor shale, micaceous siltstone and claystone.

In the oil exploration borehole Bullsbrook No. 1, the Leederville Formation is of similar lithology to its surface expression and is 68 m thick. At a borehole eight km west of the map sheet, the formation is 228 m thick and attains 1 100 m in a borehole offshore near Fremantle, indicating considerable lateral variation in the thickness of the formation.

The Dandaragan Sandstone is seen in three discontinuous outcrops to the northwest of Gingin. It is a massive to thick-bedded sandstone up to 33 m thick, from medium to coarse-grained in texture and commonly ferruginous and phosphatic. In places the sandstone contains a thin silt band towards the top of the horizon. No diagnostic fossils have been found but the Dandaragan Sandstone is thought to be of Lower Cretaceous age from its stratigraphic position. Although it appears to overlie the Leederville Formation disconformably, it is possible that the Dandaragan Sandstone is equivalent to the upper part of that formation.

The Dandaragan Sandstone is overlain, probably conformably, by an Upper Cretaceous succession consisting in decreasing age of Molecap Greensand, Gingin Chalk and Poison Hill Greensand.

The Molecap Greensand consists of greensand and glauconitic sandstone. From topographic evidence, the unit appears to be up to 28 m thick but part of this thickness may be due to slumping. Phosphatic nodules occur discontinuously in thin bands near the base (at Mount Ginginup) and top (at Molecap Hill) of the section. Minor chalk intercalations occur within the upper few metres at Molecap Hill apparently both as contemporaneous depositional, horizontal bands and as solution/precipitation pipes cutting the greensand bedding at high angles.

Gingin Chalk is a white, friable, richly fossiliferous and slightly glauconitic chalk. In some areas the glauconite content increases and forms thin beds of greensand. Landslips have obscured the chalk outcrop in some places (borehole data proving the presence of the bed) and it is possible that they have also added to the apparent thickness elsewhere. Field measurements indicate a maximum thickness of some 28 m but this figure should be used with some caution, as borehole intersections do not exceed 12 m.

On Poison Hill, a landslip zone has been mapped stratigraphically between the Gingin Chalk and the overlying Poison Hill Greensand. This zone presents an admixture of both horizons, some 'outcrops' obviously displaced but others seemingly in situ. On deductive evidence, it is most likely that the majority of landslips occurred when the Gingin Scarp was being formed early in the Pleistocene. Similar landslips have mixed Molecap Greensand with the chalk and/or Poison Hill Greensand, but these have not formed such a distinct mappable unit.

The Poison Hill Greensand consists of a coarse to medium-grained, thick-bedded ferruginous and glauconitic sandstone above crudely-bedded greensand and glauconitic sandstone. Several springs rise at a similar level near the base of the unit, possibly indicating the presence of a more argillaceous layer which does not appear at surface. The Poison Hill Greensand outcrops are variably laterized. Drilling has shown the unit to be at least 41 m thick in the type area at Poison Hill. Foraminifers and microplankton from a sparse fossil assemblage indicate a Senonian, possibly Campanian, age for this unit.

Laterization of the Poison Hill Greensand is more complete in some sections and these have been mapped as a separate geological unit where distinct and continuous. The unit almost certainly grades into the 'Czl' laterite and has been divided from it at a transitional boundary along which the identity of the parent rock becomes uncertain. It is probable that much of the 'laterite' mapped also originated from Poison Hill Greensand.

QUATERNARY

Quaternary deposits cover the mapped area west of the Gingin Scarp and are probably less than 60 m thick at any given locality. They consist principally of clayey alluvial sands on the Pinjarra Plain and various colluvial deposits on the Dandaragan Plateau and Piedmont Zone.

Laterite occurs widely in discontinuous outcrops on higher ground. It is typically a ferruginous, siliceous laterite and forms layers from 1.5 to 3.0 m thick, overlying a weathered rock zone which can be up to 30 m thick. The laterite is associated with eluvial quartz sand. The laterite is pisolitic, with the interstitial quartz medium-grained, angular to rounded, the whole being variously yellow-brown, ochre, dark red or pale grey. No bauxitic laterite is recorded from the area.

A fossil beach deposit with its base at about 75 m above present sea level has been assigned to the Ridge Hill Sandstone. The deposit consists of leached and laterized sands on the lower slopes of the Gingin Scarp. A thin basal conglomerate is seen in places and natural concentrations of heavy minerals occur south and northwest of Gingin.

The Guildford Formation is represented by variably laterized alluvial clayey sands with minor sandy clays and some loams. In the southeast of the Sheet area the character of the formation is confused by a thin wind-blown veneer of Bassendean Sand and by swamp material deposited during recent inundations. Northwest of Gingin it either covers or forms part of the Ridge Hill strandline at the foot of the Gingin Scarp. The sand grains are subangular to subrounded and vary in colour from white through greys and creams to brown. Some sections are diatomaceous and some are peaty, making distinction from swamp deposits difficult.

Subdued, fixed undulose dunes in the west of the Sheet area are formed by Bassendean Sand. The sand is typically white to grey at surface and yellow at depth. The quartz grains are frosted and pitted, fine to medium-grained and moderately well sorted. An area in the northwest of the map sheet is characterised by deep red sands where iron oxides have leached from underlying ferruginous limestones.

A chalky limestone, the Muchea Limestone occurs in many low-lying areas, generally where sub-surface drainage is slowed by an increased clay content in the sands. The limestone is discontinuous and thin but persists over a large area and is thought to have formed by an accumulation of calcium carbonate in the soil at or about the water-table. As mentioned above, some of the limestone is heavily iron-stained.

The colluvium 'Qpo' is a varicoloured (white-cream-brown), poorly sorted, poorly rounded sand which was formerly an eluvial horizon overlying the laterite but which has been partly redistributed. This unit includes minor alluvial areas where the sand has been washed into gullies. Other small patches of colluvium have formed from Cretaceous and possibly other rocks and all are laterized to a greater or lesser degree.

Holocene alluvium occupies the floors of many present day drainage lines. The main sediment is sand with varying but minor amounts of clay and peat. Where the drainage is internal or very sluggish, the peat content increases markedly, in places to the virtual exclusion of sand. These areas are mapped as swamp deposits and widely contain large amounts of diatomite.

STRUCTURE

All the strata mapped in the Gingin Sheet area are horizontal or low dipping except where recent soil creep or slumping has caused an apparently steeper dip.

Several lineaments trending north-northwest are discerned within the area, some accentuated by lines of swamp deposits or aligned drainage, others appearing merely as straight-line depressions. From results of seismic work in this and adjacent areas, it is postulated that these lineaments are the present surface expression of older, buried faulting. Minor faulting on a north-northwest trend is common within the Perth Basin sub-surface strata.

ECONOMIC GEOLOGY

CHALK

Since the beginning of the century, periodic attempts have been made to exploit the Gingin Chalk for the production of agricultural lime, hydraulic lime or portland cement. It is probable that the composition of the chalk is too variable for it to be accepted as a raw material by the cement industry and the sulphur and phosphorous contents make it unsuitable for metallurgical lime. The friability of the rock and its minor potash and phosphate content make it a possibly useful source of agricultural lime for local application.

CLAY

There are no pits for clay extraction in the area. The Guildford Formation, which is extensively worked for brick, pipe and tile clays near Perth, crops out west of the Gingin Scarp but here consists of sands with only minor clay. The sandy nature of the exposed Guildford Formation renders it unsuitable for brick production by itself but little is known about its sub-surface character. Mixed with plastic clay, this material could be used for brickmaking.

Sandy colluvium, soil and sand over laterite east of the Gingin Scarp are unlikely to contain clay of commercial value. Minor clay deposits occur in Quaternary alluvium of Gingin Brook and Lennard Brook.

Unexposed, flatly dipping Osborne Formation is presumed to occur along the base of the Gingin Scarp beneath colluvium and alluvium. It is only seen in Gingin Brook No. 1 borehole where it is typically a dark green to black glauconitic, carbonaceous claystone 7.6 m thick. Although the Osborne Formation is mined for brick clay to the south of the area, the presence of glauconite and carbonaceous matter near Gingin suggest that it is unlikely to be suitable for brick manufacture here.

DIATOMITE

All deposits of diatomite on the Perth Coastal Plain examined to date are small. The great majority are confined to swamp and lake areas at or below the water-table. They have a high organic content and are contaminated to varying degrees with sponge spicules, sand and clay. Typically, the organic content of these deposits is such that, when dried, the material will burn freely and is thus self calcining.

The only deposit of diatomite investigated in detail in the map area occurs in Yeal Swamp. It is 30 to 70 cm thick and about 40 ha in extent. After being calcined with sodium chloride, samples of this material yielded a better filtration medium than did the best Californian diatomite.

In the vicinity of Gingin a grey rock, known locally as 'Casuarina Stone', was quarried from a number of places for use as building stone. The rock ranges in character from a clayey diatomite to a diatomaceous clay, the diatom content varying widely. It is not considered to be an economically viable source of diatomaceous earth and is best regarded as a building stone, the purpose for which it was used.

All samples of diatomite examined contained fresh-water species, predominantly lath-shaped.

GLAUCONITE

Glauconite is known to occur in the Molecap and Poison Hill Greensands (Upper Cretaceous), the Osborne Formation (Cenomanian to Albian) and, to a very minor extent, in the Gingin Chalk (Upper Cretaceous).

The Molecap Greensand, Gingin Chalk and Poison Hill Greensand are exposed in the immediate vicinity of Gingin townsite and scattered exposures have been recorded from a north-northwesterly-trending belt which extends off the map sheet. The greensand units carry up to 5.4 per cent K_2O over some sections below the weathered zone.

A reported 32 500 tonnes of greensand were mined from the Molecap Hill quarry between 1932 and 1960. From this, 6 600 tonnes of concentrate, indicating an average grade of 20 per cent glauconite, were exported for use in water-softeners.

Osborne Formation sandstone has been intersected in some Gingin Brook exploratory boreholes beneath Molecap Greensand. This sandstone contains small amounts of glauconite.

GRAVEL

Thin deposits of sandy pisolitic laterite overlying laterized Cretaceous sandstone in the hills north and east of Gingin have been quarried for road-making materials. They are typically less than 3 m thick, consisting of goethitic and limonitic pisolites, 1 to 5 cm in diameter, in a sandy matrix.

No stream gravels are known in the Sheet area.

HEAVY MINERAL SANDS

A deposit of heavy mineral sands has been located at the foot of the Gingin Scarp, about 3 km west of Gingin.

This deposit is assigned to the Ridge Hill shoreline but is covered by thin colluvial sands and clays of the Guildford Formation and is only exposed in some creek beds. The exploring company has announced reserves of about 2 million tonnes of heavy minerals in sand containing about 10 per cent heavy minerals.

A second deposit has been discovered between Chandala Brook and the scarp in the south of the area. The geological nature of this deposit is obscured by laterized sandy colluvium but it is assumed to represent an extension of the Ridge Hill Shoreline.

LIMESTONE

Muchea Limestone has been quarried for road construction material. The material is suitable as a base course for causeways and roads. In general the unit is less than 3 m thick and is only useful for local purposes.

PEAT

Some good quality but very small peat deposits known in swamps on the Perth Coastal Belt are mainly used as soil conditioner. However, most of the deposits examined in the map area range in quality from sandy peat to peaty sand. Many of the deposits also contain low to high proportions of diatoms.

PETROLEUM

One test well was drilled immediately south of Gingin Airfield in 1972. This well, Bullsbrook No. 1, bottomed in the Lower Jurassic Cattamarra Coal Measures Member of the Cockleshell Gully Formation at 4 257 m with no significant hydrocarbon showings. The well was plugged and abandoned.

PHOSPHATE

A thin phosphatic layer occurs near the top of the Molecap Greensand at Molecap Hill. This phosphate is contained in a minor concentration of coprolites. Some of this material was reportedly quarried from the northeastern slope of the hill but was found to be too thin for profitable exploitation.

SAND

Poorly sorted white sand overlies laterite capping the hills on and behind the Gingin Scarp. It is being quarried for construction purposes, but some seems sufficiently pure to be used in glass making.

The Bassendean Sand, which covers extensive areas west of the Gingin Scarp, yields large quantities of building and glass sand near Perth. It could probably provide commercial quantities of these materials in the area mapped. The sand is normally white at surface and yellow at depth, medium to coarse-grained, with a leached 'A' horizon developed particularly near swamps.

The coarser sand grains are typically well rounded and frosted, but the smaller grains vary greatly in shape. Accessory heavy minerals are common.

GROUNDWATER

Water is drawn from wells and boreholes to supply domestic and agricultural needs. Most groundwater is obtained at shallow depths from unconfined aquifers in the superficial deposits, the remainder from deeper confined pressure aquifers of Mesozoic age.

Unconfined (water-table) aquifers

Unconfined water occurs in superficial deposits such as the Bassendean Sand. Due to the complexity of the sub-crop contacts with Mesozoic formations, the extent and continuity of the aquifers is not fully understood.

Water-table contours (Fig. 1) show that groundwater movement in the shallow aquifers is towards the west, the movement probably being controlled by the sub-surface erosion slope of the Mesozoic rocks. These contours are generalized as a result of poor control provided by widely separated boreholes but indicate a gentle and uniform gradient. Near Gingin Brook, the curved contours show that it is a 'gaining' stream.

The depth to water varies considerably from a few metres to more than 30 m, depending on the surface topography. In some areas the water-table intersects the natural surface of the land to form swamps and lakes, particularly in Bassendean Sand interdunal areas. If production boreholes are sited close to such lakes, a lowering of the water-table may be expected to drain the lakes seasonally or permanently.

The salinity of the groundwater is generally below the potable limit of 1 000 ppm Total Dissolved Solids (TDS), increasing slightly towards the north and with depth (Fig. 2).

During storms there is some run-off into streams and lakes, providing some recharge to the unconfined aquifers. However, most recharge is by direct downward percolation of rainwater through the permeable superficial deposits. Some recharge may also result as leakage from the deeper confined aquifers but this has not been proved.

Discharge from the shallow aquifers is by evapotranspiration from plants, evaporation from lakes (about 1 780 mm per year), groundwater outflow to the west and from pumping wells and boreholes.

Confined (pressure water) aquifers

Information is based on six exploratory boreholes drilled between Gingin in the east and Guilderton to the west of this area.

The principal aquifers are the Leederville and Yarragadee Formations. The Molecap Greensand also contains domestic quality water as shown by shallow wells east of Gingin.

The salinity of the pressure water varies between 200 ppm and 1 500 ppm TDS. Generally, good quality pressure water is available, although in many places it deteriorates with depth while still being suitable for stock. The acidity of the water varies between pH 5.6 (Gingin Brook No. 5A) and 9.2 (Gingin Brook No. 2).

Recharge to the confined aquifers probably takes place along the Darling Fault zone to the east of this area and to a lesser degree by downward percolation through superficial deposits near the streams.

Development

The shallow water aquifers have not been fully exploited and development is limited to pastoral boreholes and wells and the Gingin town water supply. Typical yields from properly constructed bore holes should be about 2 000 m^3/day.

The pressure aquifers are virtually untapped but it is thought that large supplies may be available from this source. One borehole at Gingin yields 1 000 m^3/day from the Yarragadee Formation at a depth of about 210 m.

ENGINEERING GEOLOGY

No attempt is made to quantify the terms 'moderate', 'fair', etc., in this generalized summary as it is stressed that specific site investigation is essential.

LEEDERVILLE FORMATION

Very sound foundation rocks when fresh, although thinly bedded and gently dipping; when weathered they are much weaker and subject to differential erosion causing overhangs.

DANDARAGAN SANDSTONE

A sound rock of high to moderate compressive strength.

MOLECAP GREENSAND

From its engineering behaviour, this could be considered as a soil rather than a rock. It is of moderate to low natural density, high permeability and void ratio, moderate to low shrinkage when weathered and of moderate consolidation. In situ cohesion is low when fresh but moderate when weathered and partly consolidated. Seepage is characteristic and piping is common, followed by landsliding on moderate to steep slopes. In one instance, successive landslides occurred on a very gentle slope (15°) following a farm dam failure.

GINGIN CHALK

Of moderate to low natural density and high to moderate permeability and void ratio. It is of low compressive strength except where a duricrust occurs. Its strength when dry is much greater than when wet and it could behave like a soil rather than a rock. Settlement could occur under heavy and industrial structures. Slopes are unstable due to the influence of percolating water on the underlying greensand and progressive landslides are common.

POISON HILL GREENSAND

The upper sandstone is of high density, high to moderate compressive strength and strong structurally when fresh. In outcrop it forms cliffs. The underlying crudely-bedded rocks are weaker and readily eroded to undercut the competent thickly-bedded sandstone. Minor slides and piping occur where seepages emerge from the lower greensands.

LATERIZED POISON HILL GREENSAND

Has similar engineering properties to the upper portion of the parent rock.

LATERITES

Gravelly. Composed of ferruginous pisolites in a clayey matrix, these are soils of high natural density, high to moderate permeabilities (unless compacted), medium cohesion and little shrinkage. Their value as foundations is fair and under bitumen or gravel roads is good to fair.

Massive. The engineering properties of these laterites, when fresh, are good but can be very poor when weathered. They are of irregular thickness and therefore partly modified by the properties of materials underlying thin sections.

Eluvial Sands. Moderate natural density, very high permeability and void ratio and no cohesion or shrinkage unless bound with silt or clay. Settlement under load could be a major engineering hazard.

RIDGE HILL SANDSTONE

With fair to good values adjacent to foundations but settles under load and vibration.

GUILDFORD FORMATION

A wide variety of engineering properties can be expected due to various clay contents. Natural density is high to moderate, permeability is low and shrinkage and cohesion are high to low.

Houses on this formation are successfully built on columns or a concrete raft above 1 m of compacted sand. Cuts are generally stable although in the steepest cuts slides may occur.

BASSENDEAN SAND

The sand is of high to moderately high natural density, high permeability and void ratio, well drained and not subject to shrinkage. It is mainly well consolidated except near surface but has no cohesion. When dry and vegetation-free it could be remobilised. Its value under foundations is excellent to fair, under bitumen roads is excellent to good and under gravel roads excellent to very poor. Deep, steep cuts would be unstable.

MUCHEA LIMESTONE

Has moderate natural density, no shrinkage, moderate void ratio and moderate to very low compressive strength. Being thin, its engineering properties will be modified by underlying units.

COLLUVIUM

Variously of high to moderate natural density, high permeability (low in alluvial areas), high void ratio, very low to no shrinkage and high to moderate consolidation except near surface. Its value as a foundation under bitumen roads is good to fair and under gravel roads good to unsuitable. Requires stabilisation if exposed to erosion.

SANDY COLLUVIUM

High to moderate natural density, variable permeability, good to moderate consolidation, high to moderate void ratio and low shrinkage. Under roads its foundation value is good. Moderately steep cuts are stable.

LATERIZED ALLUVIUM AND COLLUVIUM

This unit usually has a moderate natural density (sometimes high), low permeability, very low void ratio and is mainly well consolidated except at surface. Although of intermediate to low shrinkage, it can have high shrinkage where the clay, silt and organic contents are high. It could include lenses of expansive or active clay which would greatly lower structural stability. As a foundation it requires an overlying, compacted sand mat. Deep, steep cuts should be stable unless the soils include permeable beds or connected lenses where piping could occur.

ALLUVIUM

Natural density variable from high to low, medium to low permeability, moderate void ratio except where higher peat or clay content leads to low void ratio and high shrinkage. Areas of high pore pressure could be expected where impervious, lenticular plastic bodies occur.

Irregular settlement under load could be a major problem due to poor consolidation and water-table fluctuation. Moderate and steep cuts could be unstable and piping could occur. The value as foundation is fair to poor beneath bitumen roads and fair to unstable beneath gravel roads.

SWAMP DEPOSITS

Soils of moderate to low natural density, moderate to low permeability, high to moderate void ratio and high to moderate shrinkage. They possibly include irregular clay lenses, some of which could be sensitive. As a foundation the deposits would be very poor, causing irregular settlement. The near-surface water-table would impede excavations and influence building stability. These soils could support minor residential structures with appropriate design. Beneath bitumen roads their value is fair to poor and is unstable beneath gravel roads. Steep cuts will be unstable, particularly after wetting and drying.

EARTHQUAKE HAZARDS

The mapped area is in the 'C' earthquake risk zone. This is a weak seismic zone.

ENVIRONMENTAL GEOLOGY

Some aspects pertaining to the geological environment have been covered in earlier sections (for example water supplies and landslips) and others overlap to some degree: waste disposal is important geologically where water supplies could be contaminated; farming where it results in soil erosion.

WASTE DISPOSAL

Dry wastes. Sites would be available throughout the Dandaragan Plateau with little risk to water supplies. Small safe sites probably exist within the Bassendean Dunes where the water-table is sufficiently deep to allow effective filtration by the highly permeable sands.

Non-toxic liquid wastes. Much of the Dandaragan Plateau is covered by sand thick enough to filter such wastes in bulk but elsewhere the sand capacity is probably insufficient to protect the groundwater.

Toxic wastes. No suitable sites are available for toxic waste disposal without a permanent seal, e.g. concrete around steel drums.

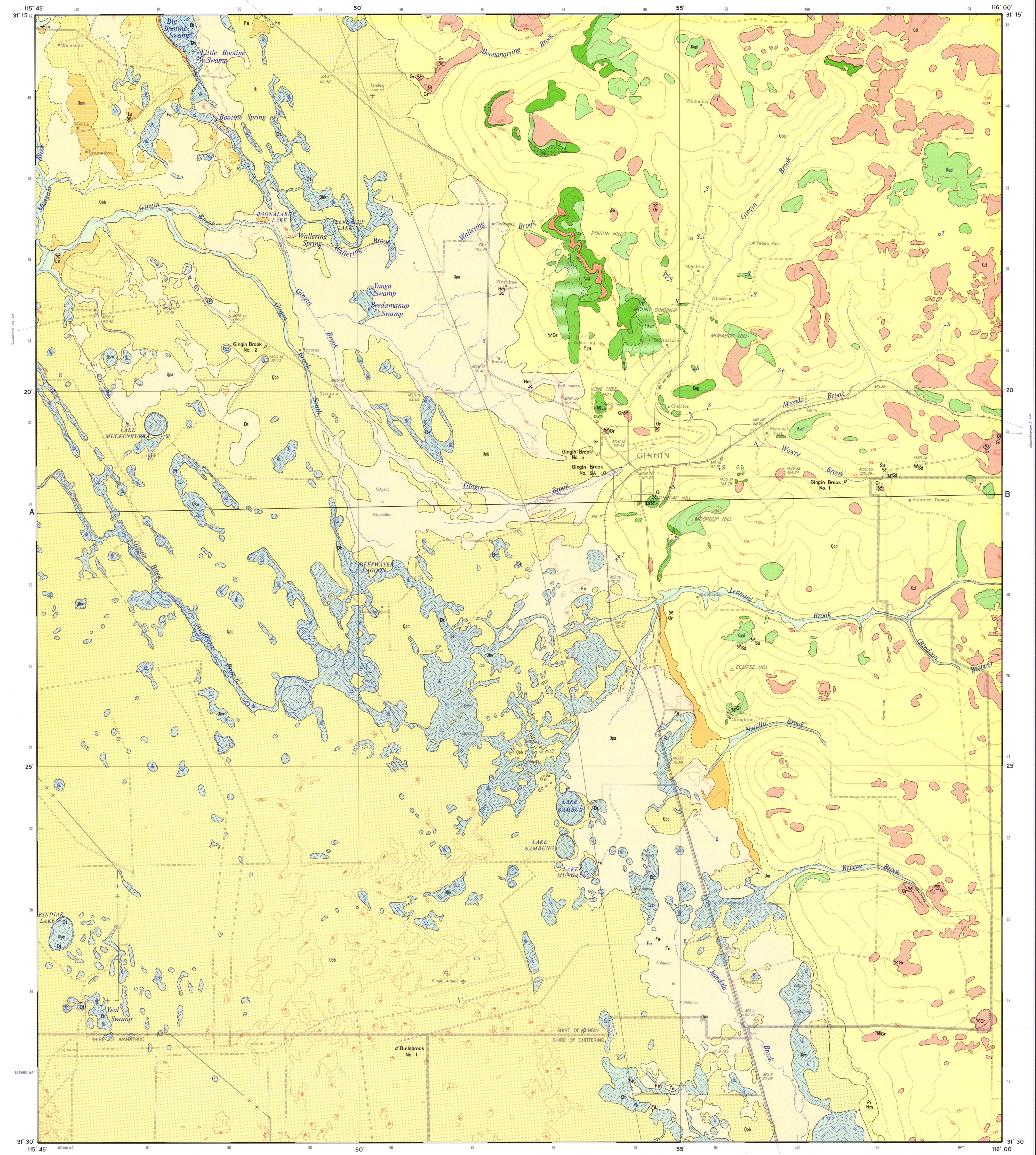
SOIL EROSION

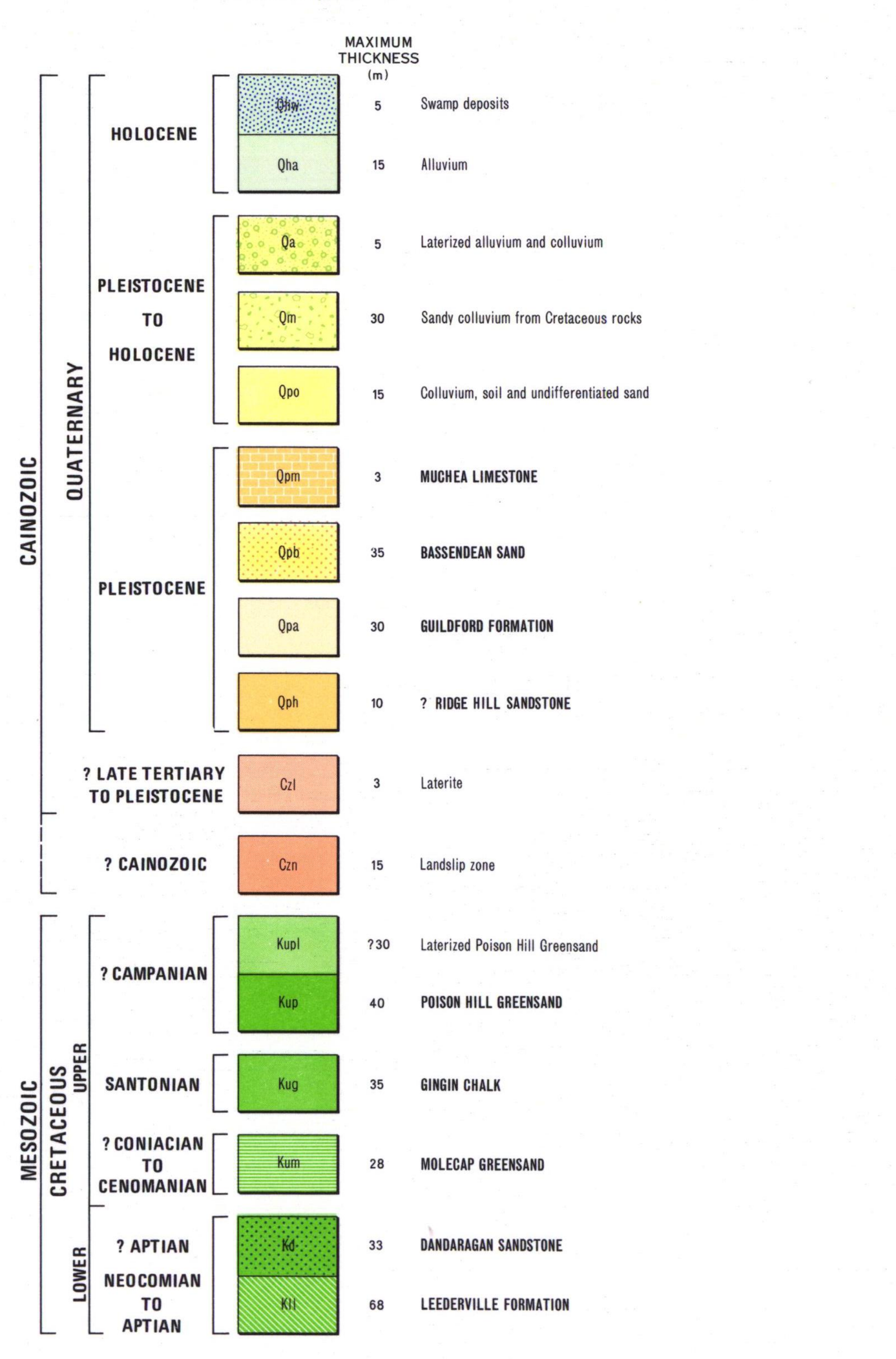
Only very minor gulleying is seen close to the Gingin Scarp but the sandy soils and colluvium are potential erosion risks where bared on steep slopes.

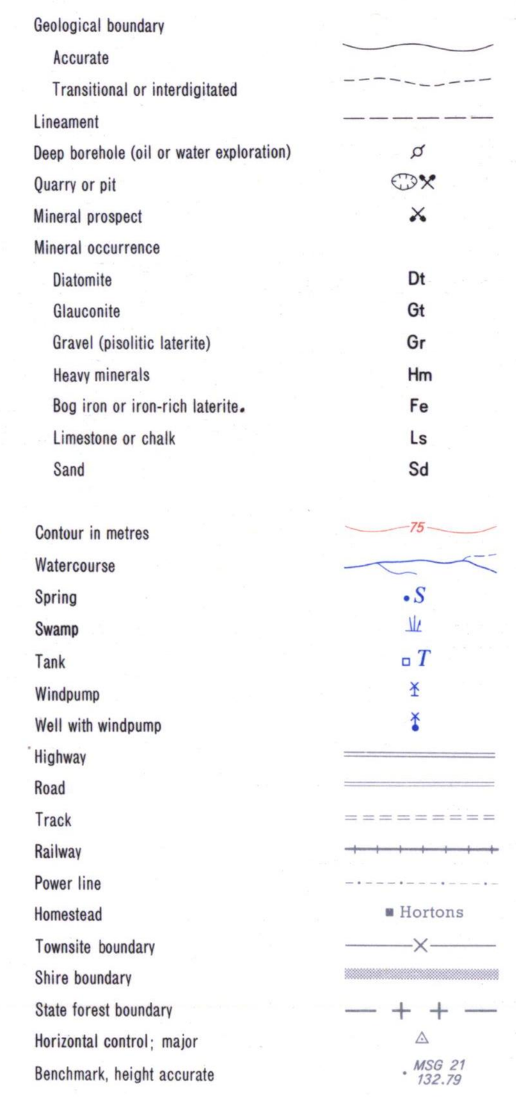
MINERAL EXTRACTION

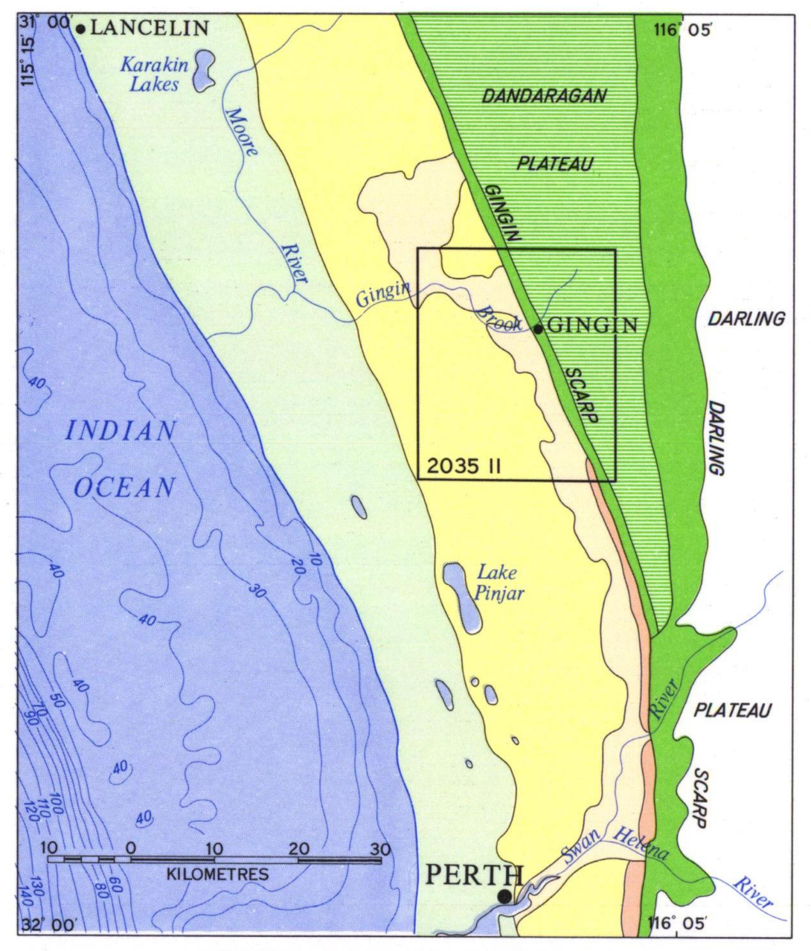
The extraction of minerals, including sand for construction and limestone for road material, is an essential part of our civilisation but should be carried out with more care than in the past. Although there are no features of outstanding scenic beauty within the Gingin Sheet area, pits and quarries should be sited with more thought for visual concealment, including planting tree screens if necessary. Worked-out pits can have future potential as rubbish-disposal sites if sufficiently separated from the water-table.

Further information may be obtained from the Geological Survey of Western Australia, Mineral House, Perth.









PHYSIOGRAPHIC DIAGRAM OF THE SWAN COASTAL PLAIN

Compiled and published by Geological Survey of Western Australia. Cartography by Geological Drafting Section, Department of Mines. Topographic base from compilations by Department of Lands and Surveys. Printed by Government Printing Office, Perth, 1976

Copies of this map may be obtained from the Geological Survey of Western Australia, in Perth.

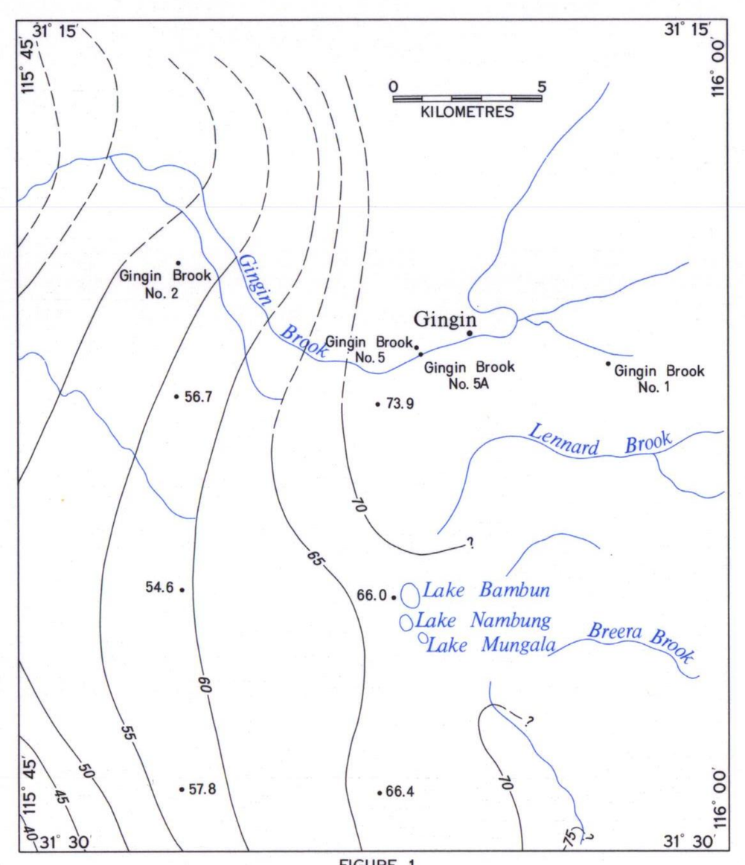


FIGURE 1
GROUNDWATER CONTOURS
5 m INTERVAL

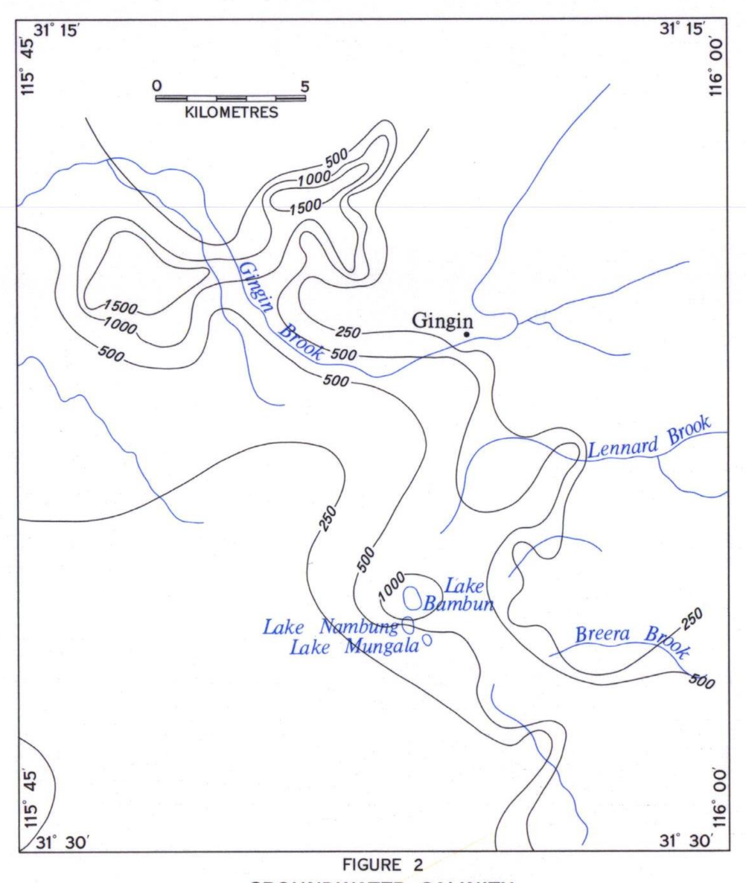
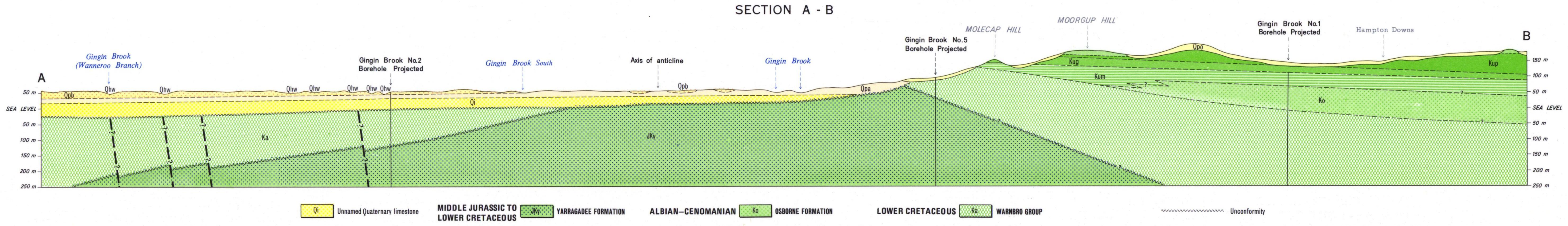


FIGURE 2
GROUNDWATER SALINITY
ISOHALINES IN ppm T.D.S.

HON. A. MENSAROS, M.L.A.
MINISTER FOR MINES
J. H. LORD, DIRECTOR, GEOLOGICAL SURVEY

DIAGRAMMATIC SECTION

SECTION A - B



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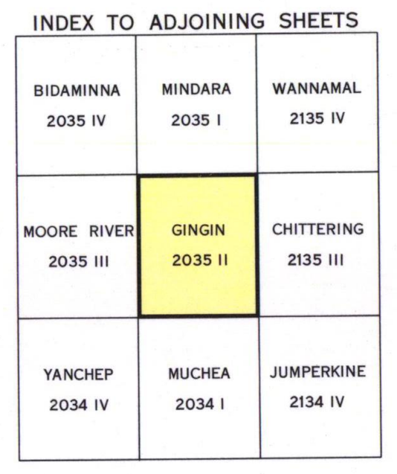
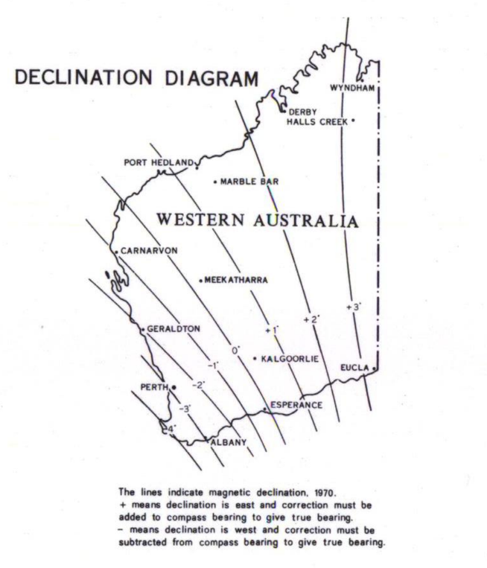


DECLINATION DIAGRAM



SCALE 1:50 000

KILOMETRES

CONTOUR INTERVAL 25 m

GINGIN
URBAN GEOLOGY
2035 II

FIRST EDITION 1976