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# Notes on Opalization in South - Western Queensland

by

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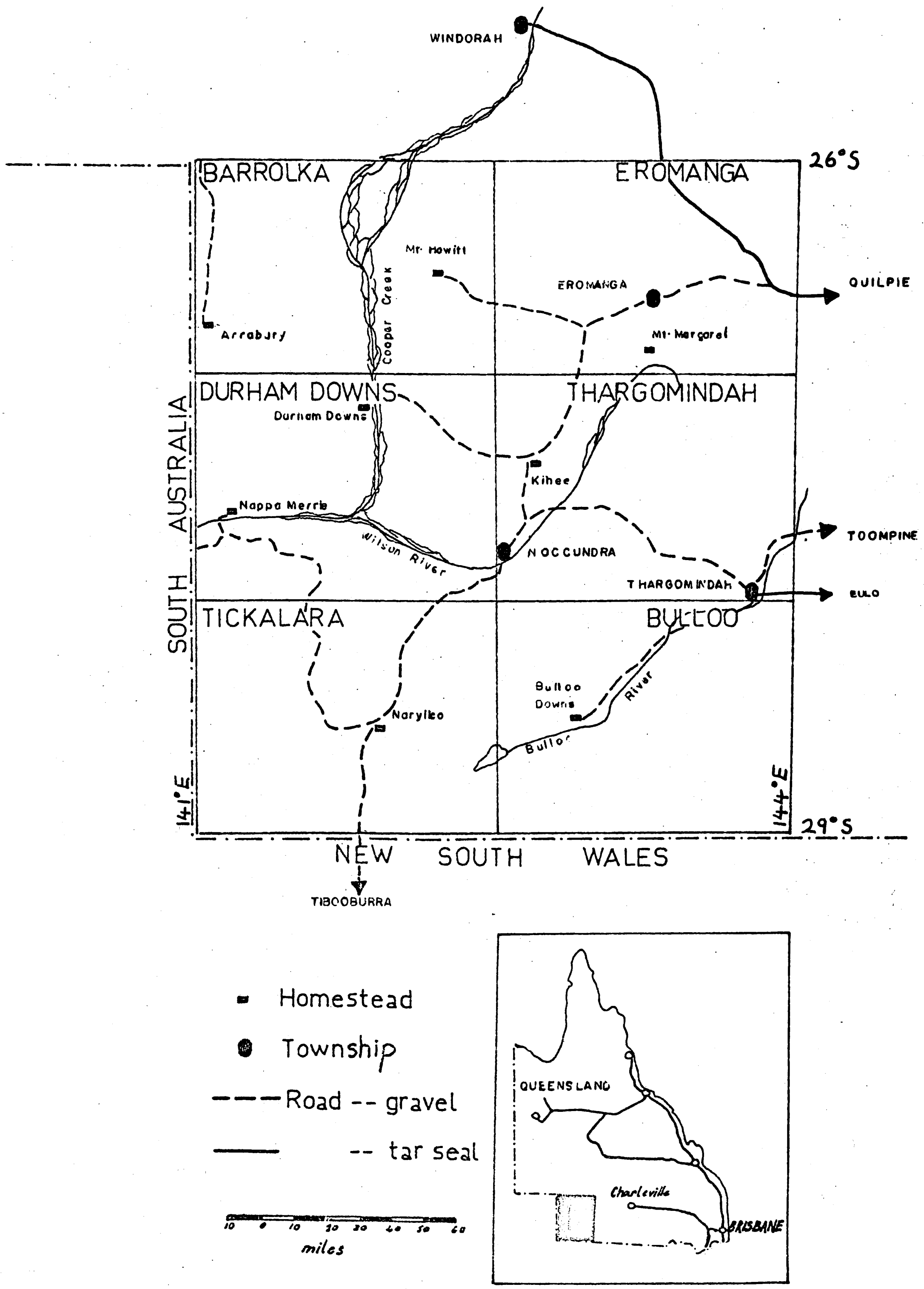
FIG 1.

# LOCALITY MAP

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## SUMMARY

Opal mines in the Eromanga area were examined during regional mapping by a B.M.R. party in 1967. Precious opal occurs in the mottled and pallid zones of chemically altered Winton Formation sediments. The opal occurs in two main forms, (a) as 'sandstone' opal formed at and above an impervious horizon and (b) as 'boulder' opal where the opal is associated with ironstone concretions. The sandstone opal apparently formed in areas of dammed up water in the zone of intermittent saturation. Boulder opal formation is not understood. Opal occurs where Tertiary sedimentation was thin. In areas of thicker Tertiary sedimentation at the time opal was forming siliceous solutions may only have affected these Tertiary sediments which were possibly unsuitable for precious opal formation. Studies at Andamooka have revealed a possible structural control for opalization. Detailed mapping is needed in western Queensland to investigate this possibility.


## INTRODUCTION

Regional mapping at 1:250,000 scale of the south-west corner of Queensland (see Fig. 1) was carried out in 1967 by a B.M.R. geological field party (Senior et al. 1968). During this mapping the writer had an opportunity to visit and examine many of the opal mines in the Eromanga Sheet area. In the course of regional mapping, other opal prospects were mapped on the Durham Downs and Thargomindah sheet areas (see Fig. 2). Most of the mines visited were abandoned but sporadic working was going on at some of the more accessible mines. This working was confined to old mines and no active prospecting was being carried out.

Jackson (1902) made an extensive survey of opal mining in the western Queensland fields at a time when many of the mines were in operation, and he was able to acquire useful information from the miners. Cribb (1948) examined the Hayricks Opal Mine. These reports together with others on opal occurrence in western Queensland were later compiled by Connah (1966).

## REGIONAL GEOLOGY

The area mapped comprises part of the Eromanga basin, a sub-basin of the Great Artesian Basin. Cretaceous and Cainozoic sediments form the only outcropping units.

The Cretaceous outcrop is restricted to the Winton Formation which is exposed over a vast area of western Queensland. In the area mapped its maximum thickness is 3500 feet (Senior et al. 1968). The Formation consists of interbedded fine to medium grained labile sandstone, siltstone and mudstone, with some thin coal seams. The units are commonly calcareous and plant fragments are found throughout the Formation. Petrological studies of the sandstones have shown that quartz varies between 2% - 20%, rock fragments between 20% - 65% and feldspar between 5% - 20% (Bastian 1963; Galloway 1967 (a) (b)). The environment of deposition of the Winton is believed to have been a large continental lacustrine and fluviatile intra-cratonic basin (Senior et al. 1968).

Post depositional near surface chemical alteration affected the Winton sediments to a depth of 300' in places (Gregory et al. 1967; Senior et al. 1968). It is in these leached and altered sediments that precious opal occurs. Subsequent to this alteration there was a period of erosion during which the leached profile was in part extensively stripped, and the present variation in thickness is probably due to this erosion of a uniformly thick zone rather than to different depths of chemical alteration from area to area (Gregory, et al. 1967).

Tertiary sediments of the Glendower Formation unconformably overlie the altered Winton rocks. The Glendower Formation consists of a fluviatile series of quartzose sediments. Quartz sandstones, conglomeratic quartz sandstones and quartz conglomerates predominate with minor argillaceous interbeds. In the areas where precious opal has been found these sediments are generally thin or absent (see Fig. 2).

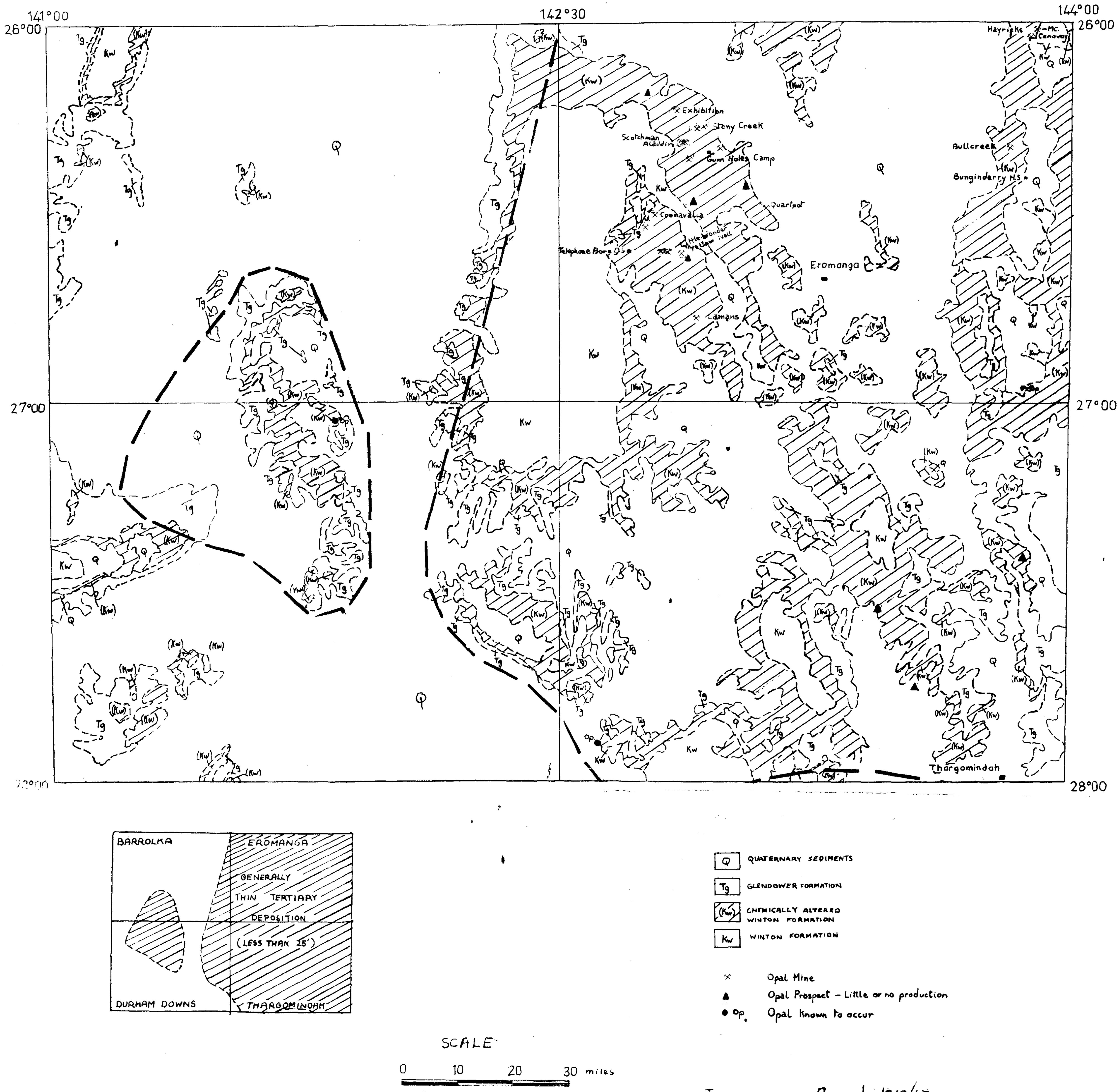
Over most of the Eromanga Sheet area the Tertiary hill cappings are no thicker than 15' and large areas have been completely stripped of Glendower sediments.

A period of leaching and silicification has affected the Glendower Formation (see Alterations). Subsequent to this alteration folding occurred producing broad open folds with dips generally less than 5°. Faulting at depth produced monoclinal structures in the Cretaceous and Tertiary and the steep limbs of these folds may have dips of 20-30° (Gregory et al. 1967; Senior et al. 1968).

The unaltered Winton sediments exposed in the core of the folds have been eroded to produce a rolling downs topography. Flanking the major structures the leached Winton rocks outcrop as steep sided hills separated by flat or slightly undulating country characterised by the multicoloured nature of the rocks. Commonly a black pediment veneer of ironstone gravel covers the lower slopes of the hills. The silicified Glendower (silcrete) forms a steep-sided capping to many of the hills and mesas. Where there was non-deposition of the Tertiary or it has been stripped a hard red-brown fossil soil caps many of the hills (see Alterations and Fig. 3, c, d).

Fig. 2.

# SURFACE GEOLOGY AND LOCATION OF OPAL MINES

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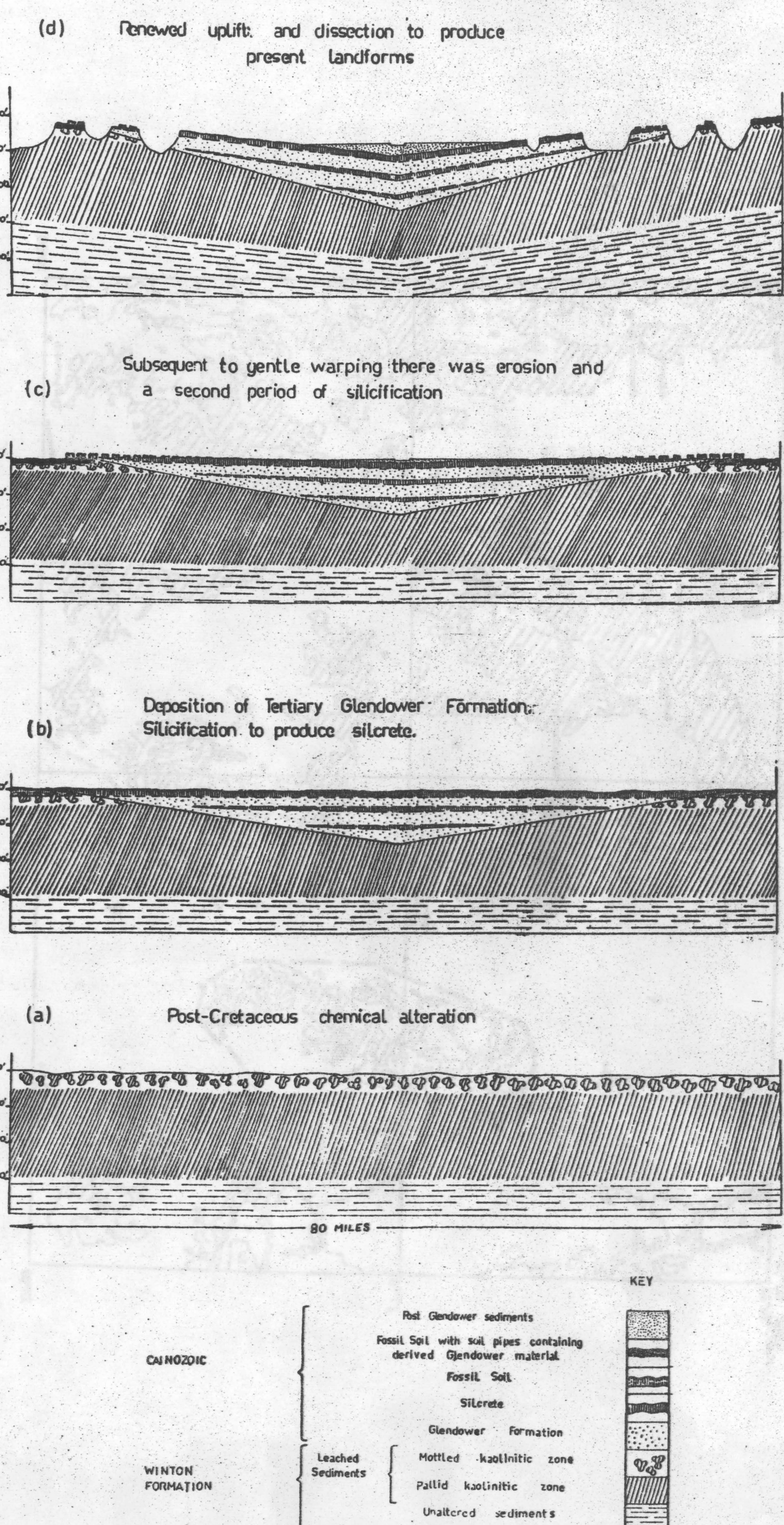
DIAGRAMMATIC REPRESENTATION OF POST CRETACEOUS GEOLOGICAL HISTORY

Fig. 3.

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Recent deposits covering the Glendower and Winton sediments consist of red earths, silcrete gravel, alluvium and sheet and dune sands.

## ALTERATION OF TERTIARY AND CRETACEOUS SEDIMENTS

Buchanan's original definition of laterite was of an indurated clay "full of cavities and pores and containing a very large quantity of iron in the form of red and yellow ochres". He noted that on exposure to air it became as hard as brick. Later workers noted the common association of the iron-rich laterite with a soil profile which contained leached and mottled zones. Prescott and Pendleton (1952) use the term laterite "in the original sense used by Buchanan and the early geological workers in India extended only by the recognition of the existence of correlated occurrences such as ferruginous gravels and its association with a characteristic profile". Noakes and Traves (1949) suggest using the term laterite in the widest sense, applying it to all or any of the zones of the laterite profile. Connah and Hubble (1960, p. 373) believe that the "application (of the term laterite) to the complete laterite profile, or to any part of it, other than the ironstone material, is strictly incorrect". Whitehouse (1940) states "there is one point of general agreement, laterites are soils formed under conditions of very great leaching that is to say in areas of high rainfall".

In the area mapped in south-west Queensland where the zone of alteration is in parts 300' thick there does not appear to be any representative of a ferruginous "laterite". It is also probable that two or more periods of leaching have been superimposed. Although the similarities to a "lateritic profile" are recognized the writer prefers to use the term 'laterite', in a restricted sense and to refer to the observed alteration as a chemically altered profile; this being divided into a mottled kaolinitic zone and a pallid kaolinitic zone.

## ALTERATIONS

### A. Cretaceous

Within the leached Winton rocks a division is made into an upper mottled and a lower pallid zone, although the mottled zone occurs only where there was little erosion and deposition in the early Tertiary (Fig. 3b).

#### Mottled Kaolinitic Zone

This zone is generally less than 20' thick with gradation down into the pallid zone.

The mottling consists of red-brown and white kaolinitic patches (Photo 1). Thin tubular cavities with an iron-rich rim are sometimes found in this zone and opaline silica may be found within these cavities (see Pipe Opal). Locally occurring are "pods" up to a foot in length of secondarily brecciated parent rock with an iron rich cement.

b

Within the mottled zone ironstone concretions are found. Some contain veins of precious opal and in places have been mined, (see Photo 1).

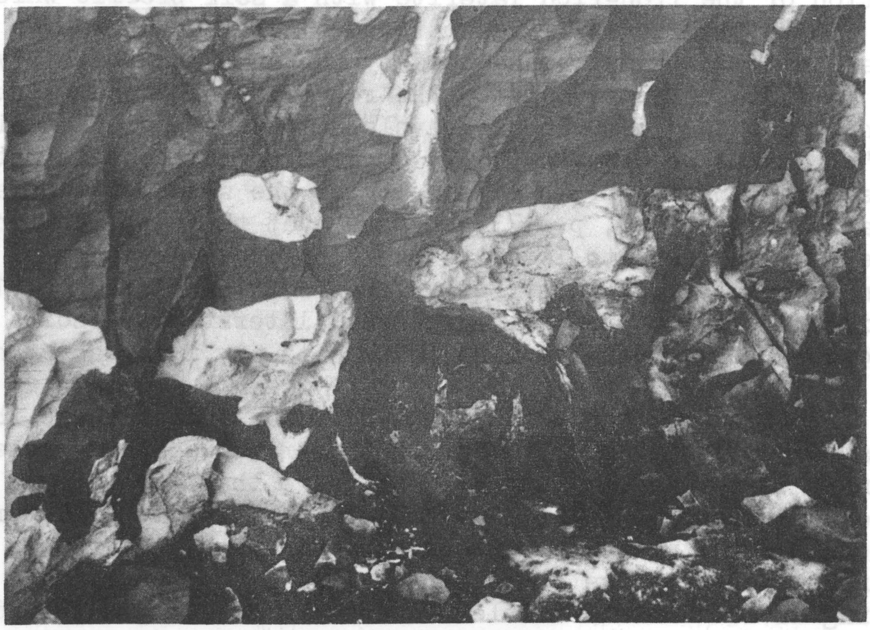

Photo 1. Ironstone concretion in mottled zone at Coonavalla Opal Mine

Pallid Kaolinitic Zone

This is a thick zone consisting largely of soft, porous, light coloured (white, pink, purple, yellow) thoroughly leached rocks. Gypsum veins and layers are fairly common. Also within the zone are beds of porcellanite - hard, white silicified mudstone and siltstone.

Thin iron enrichment occurs at several levels. Ironstone bands formed above impervious horizons have in places been opalized (see Sandstone Opal).

Also irregular iron veins, iron stainings and concretionary ironstone horizons are common. The concretionary horizons may consist of an ironstone bed up to a foot thick, containing concretionary masses in an iron-rich matrix. (Gregory et al. 1967). More commonly in the area mapped where opalization occurred the concretions are separated, although thin iron veins may connect them. The concretions consist of concentrically arranged shells of siliceous ironstone. Specimens of ironstone have been analysed (Jauncey 1964) and contain between 44.2% and 84.6% $Fe_2O_3$ and between 11.2% and 32% $SiO_2$.

The miners' term for precious opal from these concretions is 'boulder opal' (see Boulder Opal).

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B. Cainozoic

The quartzose Glendower sediments usually contain a matrix consisting of white clay minerals. Much of the matrix is probably derived from the underlying clayey Winton sediments (Gregory et al.). But further leaching causing mobilisation of silica and precipitation to form silcrete is probable. These silicified beds have been found at several levels within the Glendower sediments (Senior et al, 1968). The silica consists dominantly of amorphous silica with minor chalcedony. Occasionally veins of amorphous opaline silica are found in the silcretes (Appendix T.S.1).

Mottling has been recorded from the Glendower sediments, and mottling and spheroidal iron concretions from the Moses sandstone - believed to be early Tertiary in age, found on the Connemarra and Brighton Downs Sheets (Jauncey, 1964; Vine, 1964; Gregory et al. 1967).

Fossil Soils

Where the Glendower Formation sediments are in situ they rest unconformably over the pallidor mottled Winton Formation. Where the Tertiary sediments are very thin they may be completely silicified and silcrete rests unconformably over the mottled or pallid zones. The term silcrete is here restricted to the silicified quartz sandstones which are found in the Glendower Formation.

However, where the Glendower sediments are absent or represented only by remnant boulders of silcrete, (photo 2) a fossil soil is commonly developed on the altered Winton sediments.

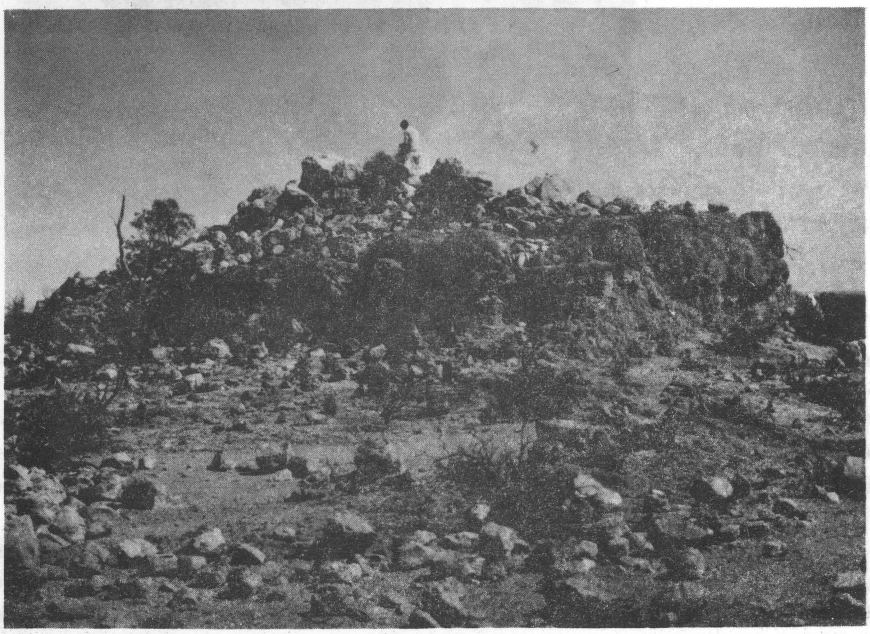

Photo 2. Remnant boulders of silcrete overlying fossil soil hill capping.

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These soils are generally only partly siliceous, they are dominantly composed of altered Winton material, they are iron impregnated and they fracture readily. Their thickest development is 30-40'. Within these red-brown soil profiles the sedimentary structures have been destroyed by brecciation in situ. Large soil pipes (photo 3) and abundant smaller cracks are developed within the profiles and may contain a mixture of recemented Glendower and Winton rock fragments.

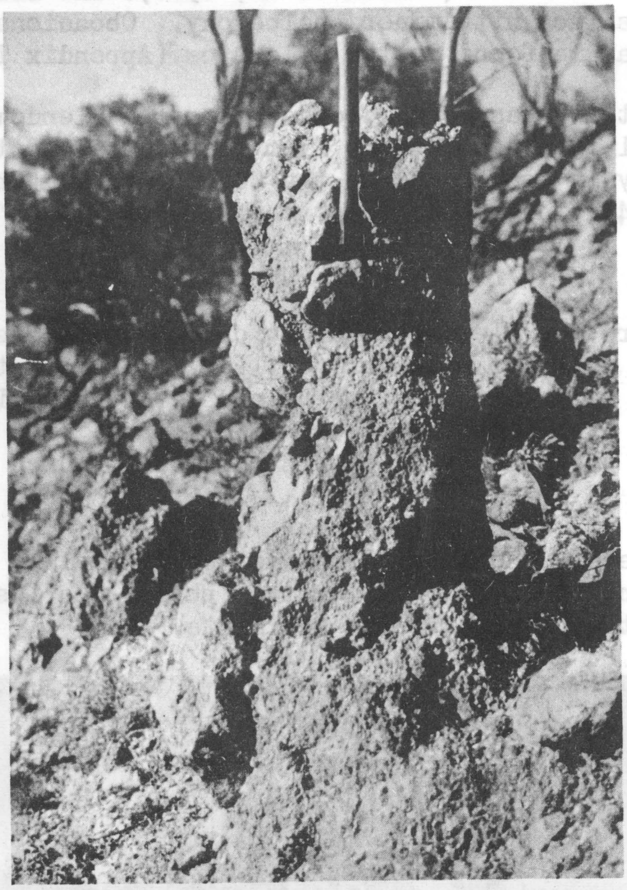


Photo 3. Remnant of soil pipe from fossil soil.

Locally, portions of the soil may have a pisolitic texture and elsewhere it is partially silicified. Rarely, small lenses of chalcedonic limestone, oval in plan, are found on the surface. Fresh cuttings through the soil commonly reveal that the mottling of the altered Winton profile continues through the soil, although this may not be evident in the weathered exposures.

The formation of the soil may in part be contemporaneous with the initial formation of the silcrete within the Glendower Formation in those areas of non-deposition of the Glendower. (Fig.3b). However, the inclusion of silcrete fragments in soil pipes points to a later formation for the soil. (Fig.3c).

Some silcretes examined show evidence of having been previously broken up and resilicified. These are composed of blocks, boulders and small fragments, some of them rounded, in a siliceous matrix. (Appendix T.S.2). It is possible that the fossil soils discussed above were formed in part during this period of erosion and resilicification. It is postulated therefore that after the initial formation of the silcrete, there was a period of erosion, possibly peneplanation, and soil development accompanied by further silicification. Subsequently there was renewed uplift and dissection leaving the soil and silcrete capping as isolated mesas. (Fig. 3d).

## OCCURRENCE OF OPAL

Opaline silica is common throughout the leached profile of the Winton Formation. In some of the sandstone it replaces the matrix. Some of the mudstone beds have been silicified to produce porcellanites, and replacement of wood and gypsum by opaline silica is fairly common. In the Glendower Formation the siliceous cement of the silcrete appears to be dominantly amorphous silica with minor chalcedony.

Occurrence of precious opal however is more restricted. It occurs in association with iron in two main forms (a) as 'sandstone' opal (b) as 'boulder' opal.

### (a) Sandstone Opal (see Fig. 4)

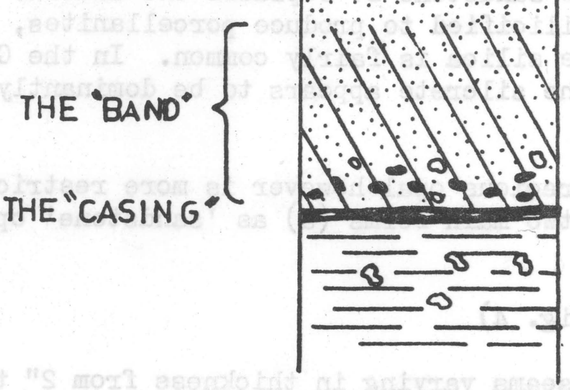
Thin ironstone seams varying in thickness from 2" to a mere film occur in the pallid zone. Invariably they occur at the junction of a sandstone with an underlying finer-grained sediment. Precious opal occurs in the seams as thin horizontal veins (Appendix T.S. 3). Jackson (1902) called the seam "the casing".

Commonly found above the seam is a zone up to a foot thick of hard ferruginous sandstone containing iron oxides and precious opal as a matrix to the sandstone (Matrix Opal). This zone was called the "band" by Jackson (1902). Within the "band" small veins and vugs containing precious opal are fairly common. Precious opal is also found in small cavities in the underlying sediments.

'Sandstone Opal' was a general term used by Jackson (1902) to describe the opal associated with the "band" and "casing".

Fig. 4.

# Mode of occurrence of 'Sandstone Opal"




1inch = 1 foot

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(b) Boulder Opal

Precious opal occurs as thin veins and pockets within iron concretions or "boulders". The concretions occur commonly in sandstone and less commonly in mudstone throughout the mottled and pallid zones of the leached profile. They vary greatly in shape from small spherical bodies less than a foot in diameter to elongate concretions up to 10 feet in length. The long axes of the concretions are aligned parallel to bedding or cross-bedding and within any one horizon they usually occur in groups or "nests". Calcareous concretions are fairly common in the unaltered Winton sediments and it is possible that these are replaced in the altered zone by iron.

The texture of the concretions varies considerably from those which consist throughout of concentric bands of hydrated iron oxides, to "embryo" concretions consisting of spherical or ellipsoidal speckled masses of iron oxides. Intermediate forms have a core of sandstone.

The most common form the precious opal takes within the boulders is as thin veins. These may be radially or concentrically arranged but more commonly are irregularly distributed throughout the boulders. In some boulders the opal forms a filling to a network of polygonal 'septarian-type' shrinkage cracks. On the Yowah Field Queensland Jackson (1902) reports precious opal forming the core of small concretions.

(c) Pipe Opal

Pipe opal is found in several forms. The 'pipes' are both horizontal and vertical. They are usually thin iron-rimmed tubules with a hollow or opal filled centre. Less commonly the tubules may be solid ironstone with concentric opal veins developed within. The horizontal pipes appear usually to be local concretionary thickenings of iron veins. These horizontal pipes are common at Opalville on the Jundah sheet area (Gregory et al. 1967). In places as at map reference 712/607 on the Eromanga sheet area vertical pipes have been found where the iron is apparently replacing woody tissue, and which contain small veins of precious opal.

Other Forms of Occurrence

1. Irregular Iron Veins

In some places precious opal is found as films within irregular iron veins. The veins are usually horizontal and occur in sandstone units, commonly in the same horizon as boulders.

2. Opal with Porcellanite

Veins and cavity fillings of precious opal were found in porcellanitic mudstone at Aladdin Mine.

BRIEF HISTORY OF MINING IN THE EROMANGA AREA

Most of the opal mines visited were working at the end of the nineteenth century. Many of them have not been worked since Jackson visited them in 1901 when he found them deserted due to severe drought conditions. The mines were usually worked from camps on nearby waterholes as at Gum Holes where remains of the camp still exist.

One of the oldest mines in the area is the Aladdin mine which dates from 1872. Many others date from the mid 1880's. The Little Wonder mine which was working in 1891 was one of the richest, and at one time 50 men worked there. Another well known mine, the Hayricks is the largest mine in the area and the lease is still held although it apparently has not been worked for some years.

In general the workings consist of a number of shallow shafts generally no more than 20 feet deep. At any one mine there may be only one or two or as many as 30 of these which were put down at random to intersect the ironstone seam or concretions bearing the opal. Occasionally drives have been dug along the intersection with the seam or boulder horizon. In places where the opal bearing band crops out adits have been dug into the side of the hill. On Mount Canaway the Hayricks mine consists of a series of timbered adits driven into the side of the mesa 120 feet below the top. The sandstone in which the concretions occur is leached and soft and slickensided shear surfaces are common throughout the workings.

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Present working is sporadic and mainly confined to reworking the old mines. In the area of the Little Wonder Mine there were 5 men working at the time the mine was visited (July, 1967). Pneumatic drills and bulldozers were being used in mining the concretions. Water was obtained from a water hole near Telephone Bore Outstation. At Bull Creek Opal Mine (see Fig. 2) the owner of Bunginderry Station has used earth moving equipment to remove 10-20 feet of overburden covering the opal bearing concretionary horizon.

Jackson (1902) records the total value of gems produced from all Queensland opal fields from 1891 to 1901 as £131,000. This compared with £135,000 for one year from the same period at the White Cliffs Opal Field in New South Wales.

## GEOLOGICAL DESCRIPTION OF SOME OF THE MINES VISITED

(a) Little Wonder Mine (map ref. 598/696 Eromanga) (see Fig.5)

Extensive workings exist at the Little Wonder Mine and in the surrounding country within a two to three mile radius of the mine. The workings at the mine are mainly adits, no more than three feet high driven into the base of a small mesa. The adits follow an opal bearing ironstone seam which crops out at this level. At its thickest development it is 2" thick. Immediately above the seam is a ferruginous sandstone with precious opal as a matrix and in small cavities.

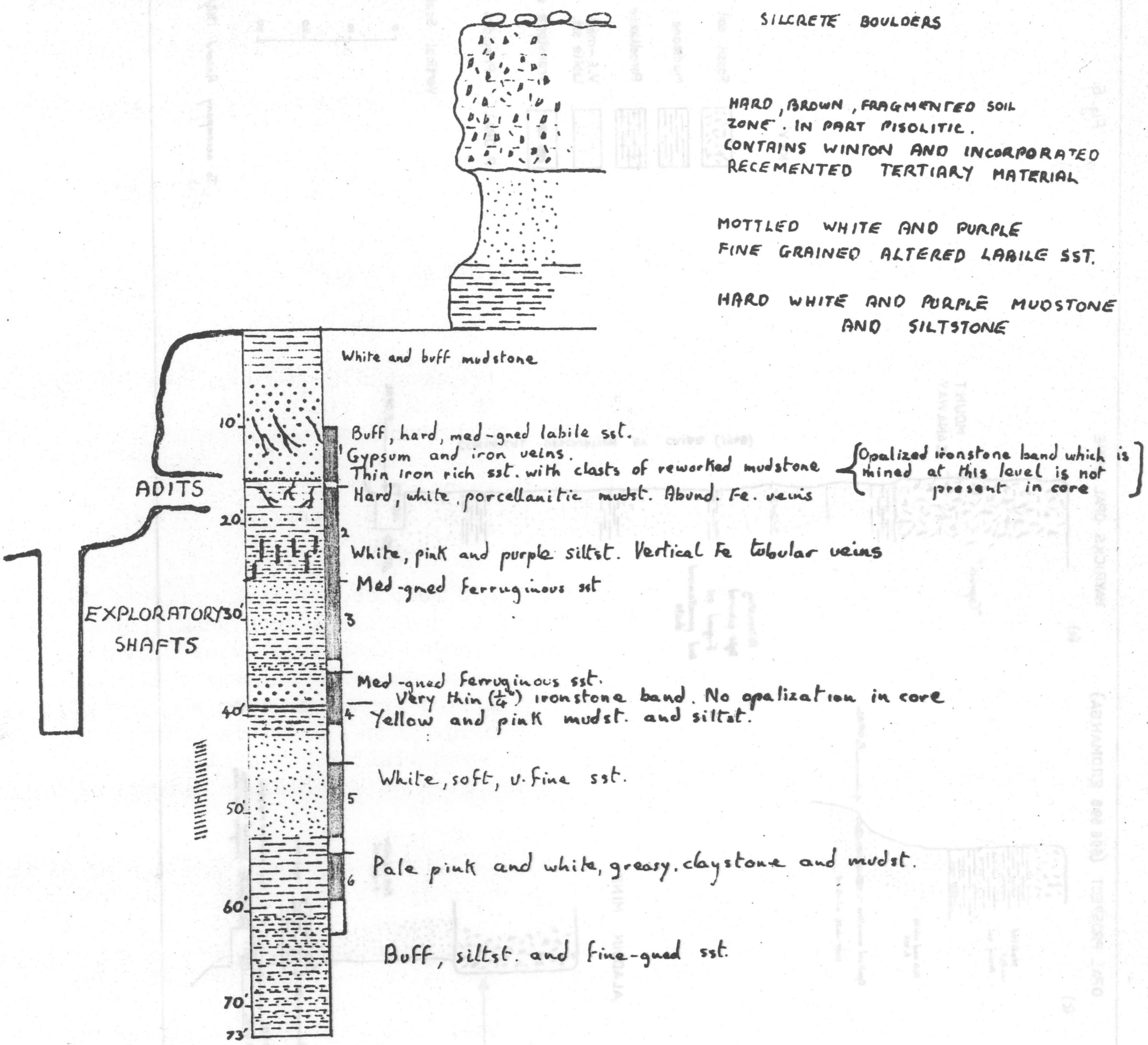
Adjacent to the adits are shafts 20-30 feet deep. Examination of the mullock heaps revealed fragments containing a thin opalized iron seam. About a quarter of a mile to the west of the Little Wonder Mine at a lower elevation a white, fine to very fine grained sandstone crops out and contains opalized ironstone concretions. Below this another opalized ironstone seam was revealed in diggings at the junction with the underlying mudstone. At this locality open cut working was in progress when the mine was visited. Two miners were working with pneumatic drills cutting into the side of the hill to extract the 'boulders' from the sandstone.

B.M.R. Eromanga Scout Hole No. 2, was drilled at the Little Wonder mine to establish the stratigraphic relationships of the opal bearing horizons. The hole was sited 30 feet below the top of the mesa. At 16 feet depth, at the junction between a medium-grained sandstone and porcellanitic mudstone no ironstone seam was cored and obviously at this position has pinched out. At 39' a $\frac{1}{4}$ inch ironstone seam was intersected at the boundary between a medium-grained sandstone and a yellow and pink mudstone. Although no opalization was present this was probably the same seam noted in the mullock heaps of the exploratory shafts. Between 42' and 53' a white soft very fine sandstone was intersected. This is lithologically very similar to the sandstone outcrop containing the opalized concretions. However, no concretion was intersected and no ironstone seam was found beneath the sandstone.

Therefore, at the Little Wonder Mine there are at least two opalized ironstone seams, probably three, and one opalized concretionary ironstone horizon. The results of drilling showed that these occurred within a 50 foot section of the pallid zone. The seams vary greatly in thickness over small distances and opalization within these also varies greatly.

Fig. 5

# B.M.R. EROMANGA No. 2. [LITTLE WONDER OPAL MINE]




CHEMICALLY ALTERED WINTON FORMATION ROCKS THROUGHOUT

Cored interval

Opalized iron concretions from this unit are being mined near the Little Wonder Mine

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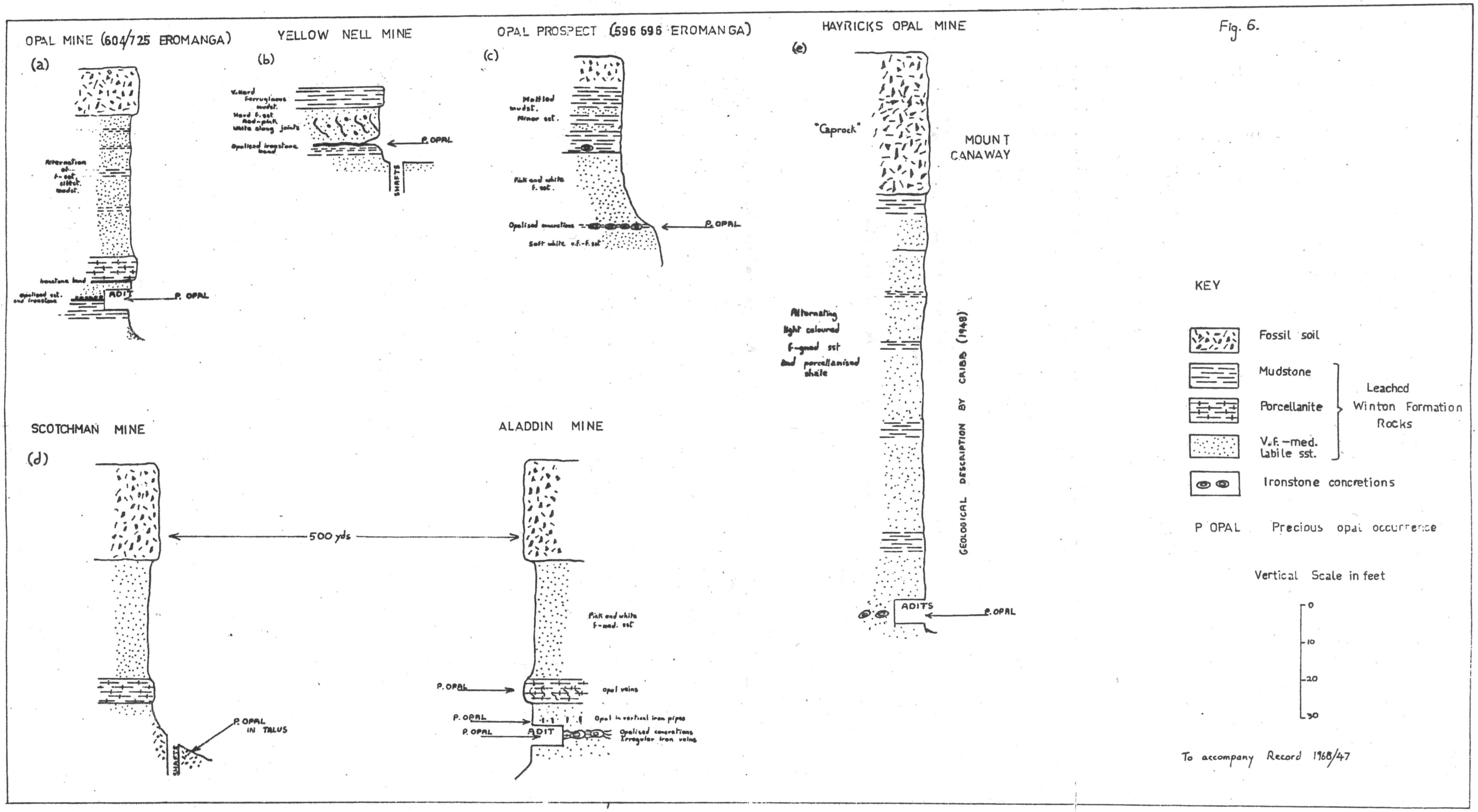


Fig. 6.

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(b) Yellow Nell Mine (map ref. 602/695 Eromanga)

Three miles east of the Little Wonder Mine is the Yellow Nell Mine. Adits have been driven into the side of a small hill where an opalized ironstone seam crops out (Fig. 6b).

(c) Unnamed prospect (map ref. 596/696 Eromanga)

This prospect was being worked at the time visited. The opalized concretions occur 35 feet below the top of the hill in a bed of siltstone 18 inches thick. They were being extracted with a pick (Fig. 6c).

(d) Unnamed mine (map ref. 604/225 Eromanga)

Abundant shallow shafts cluster around the base of the hill from which the opal is mined. Recent workings have involved the driving of an adit into the hillside where an ironstone seam crops out 50 feet from the top (Fig. 6a).

(e) Scotchman and Aladdin Mines (map ref. 603/732 Eromanga)

The Scotchman and Aladdin Mines are on two mesas, 500 yards apart. Most of the work at the Scotchman mine consisted of shallow diggings into the talus slopes where fragments of boulder and opal bearing seam were found (Connah 1966). At Aladdin the boulders occur in a sandstone about 60 feet below the top of the mesa. There is little doubt that the boulder fragments in the talus slopes at the Scotchman mine are from the same horizon as the boulders at Aladdin. At the Aladdin mine the porcellanitic mudstone which overlies the boulder bearing sandstone contains veins of precious opal (see Fig. 6d).

(f) Hayricks Opal Mine (map ref. 170/768 Eromanga)

At Hayricks Opal Mine on Mount Canaway the workings are situated about 120' down from the top of the mesa. (Photograph 4). Mining operations consisted of extensive adits and drives. The concretions are in a white to buff coloured fine to medium grained cross-bedded sandstone. Ferruginous staining along the beds is common. Several of the adits cut through a few feet of cemented scree material before entering the sandstone.

Cribb (1948) noted that the veins within the boulders commonly have the opal arranged in horizontal layers. He noted that 'potch', (a glassy blue variety of opal with little or no play of colour) passes upward into precious opal which is succeeded by common opal. This feature of horizontal banding in the opal is common to all the opal deposits. There seems, however, to be no definite order to the banding and the glassy 'potch', milky common opal and precious opal can occur in any vertical order.

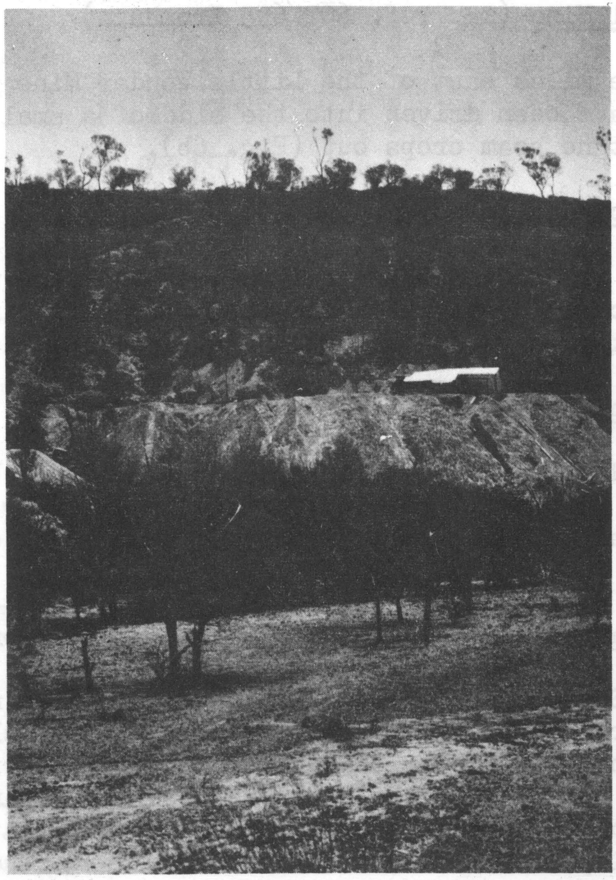

Photo 4. Hayricks Opal Mine

## FORMATION OF OPAL

The prerequisites for opalization are (1) A plentiful supply of soluble silica and suitable conditions for the solution of silica (2) Suitable conditions for the movement of silica (3) Suitable physio-chemical conditions for the precipitation of silica.

### A. Supply and Solution

Some silicates such as feldspar and clay minerals (montmorillanite) under natural weathering conditions break down and release silica into solution as monosilicic acid (Krauskopf 1967). In some cases the break down allows the silica to pass directly into an aqueous colloidal state (Jones, Biddle, Segnit, 1966; Jones, Segnit, 1966). The Winton sediments are labile and contain up to 20% feldspar (Galloway 1967 (a) (b)) providing the probable source of most of the opaline silica. The overlying Tertiary Glendower quartzose sandstones contain a matrix of clay minerals, the leaching of which may have provided sufficient silica for silicification of the silcretes.

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B. Movement of Silica

Within the mottled zone the movement of silica appears to have been local, being related to capillaries and joints. In the pallid zone the common occurrence of opaline silica and iron oxides at and above an impervious horizon suggests accumulation by downward movement of silica. Elsewhere in Australia, at Lightning Ridge (Whiting and Relph, 1958) Andamooka (Nixon, 1958) White Cliffs (Relph, 1959) and Coober Pedy (Hiern, 1965) the opal occurs in sub-horizontal leached Cretaceous (?) rocks and in these fields the opal is also localized at the contact between an upper permeable and lower impermeable horizon.

Andrews (1929) considered that the opal deposits at Lightning Ridge formed by upward movement of silica by capilliarity. Later workers (Noakes, 1949, Hiern, 1966) consider that precious opal in most Australian fields was produced by downward transportation of silica.

C. Precipitation of Silica

Electron microscope studies of natural opal have shown that it consists of a 3-dimensional network of amorphous silica spheres (Sanders, 1964). The spheres consist of a series of shells of secondary particles precipitated about a primary nucleus. The 'rank' of the opal is dependent on the packing and size of the spheres. A regular arrangement of spheres with intervening voids produces a diffraction grating. Thus a play of colours occurs as the opal is tilted - the wavelength reflected depending on the angle and the lattice parameter which is itself dependent on the size of the spheres.

The factors which allow for regular packing of the silica spheres was discussed by Iler (1965). Iler allowed 30% silica sols to settle over a period of two years and produced layers of gel exhibiting brilliant colours. Rapid settling induced by centrifuging only produced white opaque layers. He pointed out that thermodynamically, close packing is favoured over irregular packing since the greater reduction in interfacial surface energy is produced by closest packing of regular sized spheres.

If the packing is irregular and the silica particles distorted, the interference is too great to produce beams of colour by diffraction and the opal is common opal or 'potch'. In precious opal the size of the spheres generally vary in diameter from 1500Å to 4000Å and opal showing 'red fire' contains spheres larger than 2500Å. In common opal the spheres are less than 1500Å in diameter (Darragh et al., 1966).

The main difference, therefore, between common opal and precious opal is the larger size, better packing and lack of distortion of the silica spheres of the precious opal.

It is probable that precious opal formed in quiescent underground pools where slow precipitation and settling of amorphous silica took place (Iler, 1965; Darragh et al. 1966). Darragh et al. (1966) consider that silica concentration was brought about by evaporation from water trapped above formational dams for periods of millions of years. However, it may be that water loss by percolation would greatly exceed the very slow rate of evaporation that they envisage.

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Jones and Segnit (1966) believe that the clays have acted as semi-permeable membranes, concentrating the solution and filtering the silica spheres.

Field evidence from throughout Australia substantiates that opal formed above impervious horizons and at Andamooka (Nixon, 1958) detailed surveying has shown that opalization occurs in a very shallow basin structure with dips of less than $\frac{1}{2}^{\circ}$. Possibly detailed mapping in Western Queensland would reveal similar relationships between opalization and very shallow basins.

The formation and opalization of ironstone concretions does not readily compare with sandstone opal formation in that the concretions do not appear to be related to impervious barriers. Jackson (1902) noted that the sandstone around the concretions at the Yowah field was markedly clayey and Hiern (1965) used this evidence to conclude that "at every deposit opal is localised at the contact between a sandy bed and an underlying impermeable claystone". However, in the Eromanga area the sediments surrounding the concretions did not appear to be particularly clayey.

That precious opal formed in the zone of intermittent saturation where desiccation of the pools occurred periodically is apparent from field evidence. In the boulders the opal commonly fills radial shrinkage cracks, and polygonal shrinkage cracks are also common. In the iron seams cracks have been filled by later iron and opal (Appendix T.S. 3). In places the opal itself has been cracked through shrinkage and the cracks filled by later opal (Darragh et al. 1966). The horizontal layers of opal mentioned earlier (see Hayricks Mine) could be due to breaks in sedimentation due to desiccation. However, Darragh et al. (1966) regard such discontinuities as being due to raised water level.

Nowhere in the area has precious opal been found in the Tertiary deposits. This applies also to the other opalized areas mapped in Queensland (Jauncey 1964; Vine, 1963 and 1964 (a); Gregory et al. 1967).

Moreover, it has been noted in western Queensland that opal occurs in areas where Tertiary deposits are thin or absent. It is possible, therefore, that these places have been areas of uplift since early Tertiary times. These, then, are the areas where the water table has been at its lowest level below the surface, and where thick sections of Winton sediments have been subjected to percolation by siliceous solutions, producing opal at several levels in the profile. Elsewhere, in the tectonically low areas, where the water table has not dropped as far, only a thin profile has been affected and it may be that this consisted mainly of Tertiary sediments, which were not suitable for the formation of precious opal. This may have been due to the lack of suitable barriers, the mudstone beds in this fluviatile sequence possibly not having sufficient lateral extent to form suitable traps.

## FUTURE PROSPECTING

Opal prospecting in western Queensland has always depended on surface showings of "colour" - fragments of ironstone containing traces of precious opal strewn on the surface of altered Winton sediments. These traces prompted the prospectors to put down shafts in search of opalized boulders and seams. Frequently an opalized horizon was intersected which bore no correlation to the surface showings - these having been washed down from a higher level. The reason for a successful intersection in so many cases is that opaline horizons occur at several levels in the Winton sediments and where one is found there is almost certain to be more. However, usually only one horizon has been worked.

It appears from present mapping that prospecting should be confined to those areas where Tertiary deposition was thin. Detailed mapping may establish structural control for opalization. Shallow drilling may be a useful tool in this mapping and in areas of known opalization could be used to establish the various opaline levels.

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# APPENDIX

Thin section descriptions from the Eromanga sheet area.

**Thin Section I** (67584045) map ref.: - 584/691 Eromanga
Glendower Formation (silcrete)

**Hand Specimen** Hard white silicified quartz sandstone with vein of white amorphous silica. Breaks with conchoidal fracture.

**Thin Section** Moderately sorted fine to medium grained quartz sandstone. Average grain size 0.2 - 0.4 mm. Quartz constitutes about 80% of rock, rock fragments 5% and the matrix about 20%. The quartz grains are angular to sub-angular and many of them show resorption. Matrix consists of silt-sized quartz, clay minerals and amorphous silica. There are also large masses consisting apparently of opaque very dense aggregates of clay minerals - white in reflected light. Chalcedony occurs in vugs up to 1 mm.

**Thin Section 2** (67584093A) map ref. - 605/738 Eromanga
Glendower Formation (silcrete)

**Hand Specimen** Red-brown brecciated silicified rock with conchoidal fracture. Contains angular and rounded fragments of silicified quartz sandstone in a siliceous iron matrix.

**Thin Section** The section consists of angular rock fragments constituting 90% of the total, cemented by red-brown siliceous iron matrix.

The fragments consist of poorly sorted fine grained quartz sandstone. Quartz constitutes about 80%. Some grains have an iron oxide rim and appear to be corroded by the iron. The matrix of the sandstone (20%) consists of light brown clay minerals, iron oxides, silt sized quartz grains and amorphous silica. Lithic grains (mainly mudstone) constitute less than 5%.

The siliceous iron matrix between the rock fragments contains scattered quartz grains and a few fragments (up to 2mm) of mudstone.

**Thin Section 3** (67584004) map ref: - 598/696 Eromanga
Winton Formation

**Hand Specimen** Buff coloured medium grained labile sandstone with precious opal as a matrix. Parallel to bedding is an ironstone seam ½ inch thick with precious opal in thin veins parallel to the bedding.

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Thin Section

A moderately sorted medium grained sandstone. The grains are subangular to subrounded and coated with iron oxides. Quartz constitutes less than 10% of the whole. 50% of the total rock is composed of lithic grains and prismatic shaped grains composed of clay minerals possibly derived from the breakdown of feldspar. The matrix (30%?) is composed almost entirely of precious opal. The opal also replaces some of the grains. In plane polarized light the opal is very pale pink, yellow and green. In cross-polarized light some of the opal is isotropic, however the majority shows slight birefringence giving very deep greens, blues and purples.

Towards the ironstone band there is a gradual increase in iron oxides, replacing the matrix and grains. Within the ironstone band, composed of dark brown iron oxides, are a few scattered quartz (< 5%) and lithic grains. Opal occurs in sub-parallel veins up to 2 mm thick. Light red-brown iron oxides also fill the veins.