DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

CHIASTOLITE FROM THE OLARY PROVINCE, SOUTH AUSTRALIA

Rept.Bk.No. 78/132

GEOLOGICAL SURVEY

Proposed article for inclusion in Report of Investigations on ornamental stones of South Australia

BY

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DEPARTMENT OF MINES AND ENERGY
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CHIASTOLITE FROM THE OLARY PROVINCE, WILLYAMA COMPLEX, SOUTH AUSTRALIA

INTRODUCTION

"Almost all over the low rise dignified by the appellation of mount, and named by the discoverer of the chiastolites after himself, are knotted schists and chiastolite schists to be found". Thus, Sir Douglas Mawson introduced his description of the Mt. Howden chiastolite occurrence (Mawson, 1911). Mt. Howden, a classic locality of world stature is, in fact, only one of numerous areas in the Olary Province where chiastolite schists outcrop. Discovered by Mr. G. Howden at the turn of the century (Anderson, 1902; Dana, 1907), Mt. Howden originally was covered with thick talus screes of chiastolite crystals (Fig. I). After nearly 80 years, gem and mineral specimen collectors have denuded the well-known sites to the degree that some other relatively unknown localities now contain thicker screes.

This report records all known chiastolite localities and this provides alternatives to the Mt. Howden site, which should be preserved from further excessive and indiscriminant collecting.

ACCESS

Olary lies on the Barrier Highway, 400 km from Adelaide and 120 km from Broken Hill. Kalabity H.S., in the centre of the area discussed here, is 56 km north of Olary, by graded dirt road.

Access to many of the chiastolite localities is possible by conventional 2-wheel drive vehicles under dry conditions.

Figure 1 (a,b)

Chiastolite screes at Mt. Howden, at the turn of the century. Such screes at Mt. Howden have been largely removed but are still to be found elsewhere.

(Reproduced from Mawson (1911) with permission of the Royal Society of South Australia.)

Fig. 1a

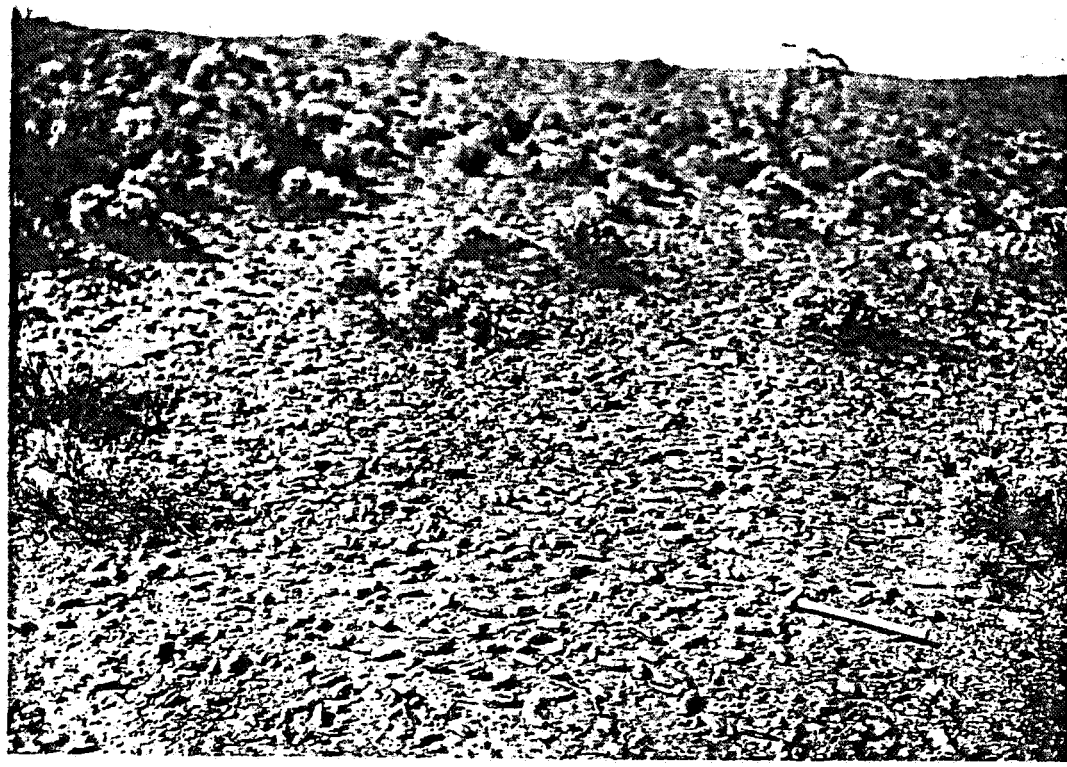

Fig. 1b

Printing for Donald Taylor Collotype C... Ltd. North Adelaide.

Fig. 2 - Chiastolite crystals displaying the characteristic internal structure, external shape and "tail" of adhering muscovite schist matrix. (Scale in cms)

Slide No: IJLC001

Fig. 3 - Sectioned chiastolite crystals, showing single and multiple, internal "crosses". They range from 2.5 to 4 cm in diameter.

Slide No. IJLC002

Fig. 4 - Sectioned and mounted chiastolites. The mounted stone is 1.5 cm across. (Brooch courtesy of Dr. N.H. Ludbrook.)

Slide No. IJLC003

Fig. 5 - Sectioned chiastolites with "tail" of muscovite schist, and chiastolites embedded in a matrix of carbonaceous schist (top).

Slide No. IJLC004 (Scale in cms)

Others, including Mt. Howden and Nankeeta Hill, require considerable care. All are easily accessible to 4-wheel-drive vehicles but tracks generally are impassable after rain.

The country is held under pastoral lease for sheep and cattle grazing and visitors should always obtain permission to enter from Kalabity or Bimbowrie H.S. before visiting any localities.

DEFINITION AND CHARACTERISTICS OF CHIASTOLITE

Chiastolites are a form of andalusite (Al_2O_3 SiO_2). Its name, according to Dana (1932), derives from chi, the Greek letter X. It is also termed macle, from the Latin macula: a spot, aluding to the spotted appearance of schists with an abundance of chiastolites. Chiastolites generally occur as porphyroblasts; that is, crystals many times larger than those of other minerals of the enclosing rock. Crystals range in size from microscopic (Fig. 6) to, rarely, over 18 cm in length, with a characteristic, distinctive cigar shape (Fig. 2). Their striking, inner, cruciform or tesselated pattern, exposed by transverse sectioning or fracturing is the result of a regular arrangement of carbonaceous impurities (up to 1% of total bulk) during the progressive growth of the crystal under metamorphism (Fig. 3). The inner pattern may change regularly along the length of the crystal. Details of this and other features of the crystallisation are given in Mawson's 1911 Memoir.

Chiastolites were popular as semi-precious gemstones, particularly in the early decades of this century. High quality specimens were sectioned transversely, and polished as a low cabochon for mounting as brooches and pendants (Figs 4 and 5).

Mawson (1911) records the popular name of "Australian lucky-stone", presumably reflecting a commercial endeavour to sell them as such.

REGIONAL GEOLOGY OF CHIASTOLITE OCCURRENCES AT OLARY

The regional geological structure of the Olary Province is shown in Figure 7 (see also Campana and King, 1958). The province consists of fault blocks of lower Proterozoic Willyama Complex separated and overlain by sediments of the Adelaidean Burra and Umberatana Groups.

The age of the original sediments of the Willyama Complex is estimated at about 1800-2000 million years before the present (Ma). The sediments consisted of sandstones, sandy siltstones and claystones (in part carbonaceous), with some limestones and calcareous clastics, cherts and baritic iron formations. Basic volcanism produced basalt flows and related rock; the possibility of acid volcanism as a source of widespread albitic rocks is currently under debate.

At about 1700 Ma, under amphibolite-grade conditions (moderate to high pressures of 3-8 kb and temperatures of 450-700^{o}C) the sediments were metamorphosed into a sequence of layered schists, quartzites and gneisses, iron formations, albitic rocks, calc-silicate/albitic breccias, alumina-rich and carbonaceous schists, layered calc-silicates, marbles and orthoamphibolites.

The intensity of this metamorphism increased from north to south and consequently the metamorphics of the Willyama Complex range from:

1. lower grade, predominantly schistose, units in the Kalabity area, to

2. schists and gneisses and migmatites in the Old Boolcoomata-Olary area, to

3. high grade schists and gneisses to the southeast, in the Mutooroo area.

Later, lower-grade phases of metamorphism, which slightly altered the mineralogy of some of these rocks, were accompanied by the intrusion of granite and pegmatite.

Within the low-grade metamorphic area of the Willyama Complex, centred on Kalabity H.S. chiastolites occur in an alumina-rich horizon which extends at least from Alconie Hill to Old Boolcoomata. With the use of other marker horizons the sequence has been traced through the low-medium grade Outalpa-Weekeroo area, and the higher grade Mutooroo area, but no chiastolites have yet been recorded in these areas.

MINERALOGY OF OLARY CHIASTOLITES

Chiastolite, a variety of andalusite, is found in the Willyama Complex in alumina-rich schists which are also usually carbonaceous. Where the pelitic schists are less carbonaceous, they usually contain other aluminous minerals such as common andalusite, sillimanite, kyanite, chloritoid and corundum, as well as garnet and tourmaline.

Both the common andalusite and chiastolite, and, most likely, the other minerals mentioned above, were crystallised as porphyroblasts during the earliest, 1700 Ma amphibolite-grade metamorphism. Subsequent metamorphism has in part, altered or retrogressed these minerals. Thus knotted schists contain ovoid clots of coarse mica replacing or mantling

original andalusite or corundum, and what was apparently sillimanite may consist now of fine-grained mica.

In particular, chiastolites may have been retrogressed in part or whole to very fine-grained pinite (a variety of muscovite). The following range of minerals may be found;

1. completely unaltered chiastolite: distinguished by a notably cleaner, translucent, pink-grey interior
2. chiastolite largely or totally altered to pinite: megascopically this material appears to be chiastolite, but is less translucent and more cream coloured. A change in hardness from that of andalusite (6½-7½) towards that of mica (2½-3) accompanies the conversion to pinite. On occasion, the pinite may be so fine grained as to be identified as andalusite under the petrographic microscope but resolvable as pinite by x-ray diffraction
3. rarely zoned chiastolite, with a cream fine grained mica aggregate pseudomorphing the outer zone and a rectangular core of pink unaltered andalusite (c.f. Fig. 6).

Pinitised chiastolites are suitable as specimen material, but fresh, unaltered material is preferred for cutting and polishing.

GEOLOGY AND DESCRIPTION OF CHIASTOLITE OCCURRENCES

The location of chiastolite-bearing schists are shown in Figures 7 (locations 19-22) and 8 (1-18).

Alconie Hill (Locality 1) provides a good exposure of the lower-grade metamorphics found in the Willyama Complex. The easterly dipping sequence is as follows, from the western base of the hill to the top:

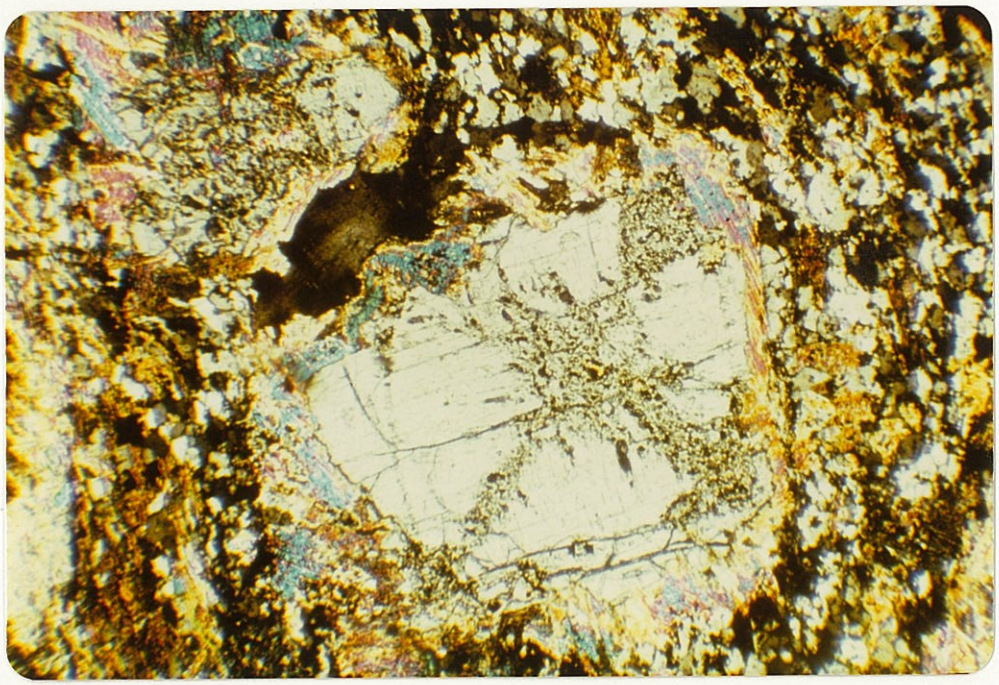

Fig. 6 - Thin-section photomicrograph of chiastolite schist, under polarised light. The chiastolite is at centre (off-white), with its imperfectly formed cross, surrounded by an alteration rim of muscovite (pale blue), and embedded in quartz-muscovite-feldspar schist. (The chiastolite crystal is about 1 mm across).

Thin section No: T.S. 27630 (p628/71)

Slide No: IJLC005

a) fissile, fine-grained muscovite schists and quartz-muscovite schists which grade up into well-layered to massive albite-actinolite calc-silicate rocks. These are overlain by

b) a quartz-muscovite schist which contains a layered calc-silicate-marble rock.

c) the schist thereafter becomes more pelitic with chiastolites in an originally more carbonaceous section, overlain by

d) knotted schist with dark porphyroblastic andalusites.

e) near the top of the hill the knotted schist becomes a silky, retrogressed schist which probably contained sillimanite or chloritoid, as well as small cubes of pyrite now oxidised to limonite.

Chiastolites, with well formed internal structures, are littered over the lower western slopes in abundance. At the southern end of Alconie Hill, excellent examples of thick, bladed aggregates of muscovite and long, thin, penetrative columns of tourmaline are exposed in a pegmatite quarry.

Mt. Howden area

The sequence here, of quartz-muscovite schists, laminated calc-silicate rocks, pelitic and chiastolite schists, muscovite schists and calc-silicate marbles is similar to, and stratigraphically equivalent to, that of Alconie Hill. Chiastolites are confined to a single bed which is repeated by folding. The distribution and petrology of rock types at Mt. Howden is described by Flint and Flint (1975) and Michelmore (1971).

a) West of Toraminga Dam: At Locality 2 rare chiastolites are shed from a poorly outcropping but spectacular,

albite actinolite/hornblende breccia. To the north, along strike, at Locality 3, excellent chiastolite crystals, 5-18 cm long, are shed in profusion from a very poorly outcropping grey schist. Although relatively untouched, Locality 3 would be rapidly depleted by overzealous collecting due to its limited extent.

b) The dark grey schist extends northwards along strike to Localities 4 and 5. Rare schist outcrops and weathered-out chiastolites occur at Locality 4. At Locality 5, a dark grey graphitic schist sheds a scree of chiastolites beside an albitic calc-silicate horizon. The schist grades into a knotted, red-brown schist bearing ovoid porphyroblasts suggestive of retrogressed andalusites. Northeast of Locality 5, the chiastolite schist horizon is largely obscured by a quartz scree which contains rare chiastolites. This crosses a track at Locality 6, where chiastolites occur in a scree from an adjacent subcropping ironstone gossan.

c) Repetition of this schist horizon to the northwest by folding results in outcrop of a thin zone of chiastolite schist littered with chiastolite/ironstone scree, at the site of the southern Mt. Howden mines (Locality 7). The schist extends north-northeast to the Bimba Mine area, and spectacular chiastolite screes are developed along it between Localities 7 and 8. Further along strike at Locality 9, chiastolite schists outcrop in contact with quartz-mica schist and cream, fine grained, pyritic albite rocks into which copper prospect shafts have been sunk.

d) Mt. Howden, Locality 10, is the classic locality of Mawson (1911). Well developed chiastolites are shed from a

grey, graphitic, knotted schist which occupies a northeast-plunging antiform. This schist is overlain by a pyritic, cobaltiferous marble and layered calc-silicate marble, often spectacularly folded, which were explored and mined for copper and cobalt (Campana and King, 1958; Michelmore, 1971). The locality has been denuded by collectors, to the degree that after heavy rain the number of shed crystals increases noticably.

Western Calico Creek area

a) From Locality 6, grey chiastolite schist outcrops extend northwards along strike to Locality 11 where particularly large crystals are often found in the surface scree.

Crystals range in size from a few cm to 18 cm long, and up to 5-6 cm across, and may be fresh or variably altered to pinite. Small, delicate "butterflies" or "flowers" are common where the crystals have been fractured transversely. The smaller crystals are more commonly fresh and unaltered.

b) Further along strike at Locality 12, dark very coarsely porphyroblastic schists bearing angular to cuboidal crystals of andalusite and chiastolite form a long, low, rise. The porphyroblasts are similar to those figured by Mawson (1911, Fig. IV) from his Pootharingla locality. In this area the pelitic schist outcrop is more than 1 km wide. A similar width of outcrop is also present at Nankeeta Hill (Nancatee or Nanceeta, of Mawson, 1911) (Locality 13), and nearby localities. Nankeeta Hill consists entirely of dark, graphitic, sandy schists and medium to coarse grained muscovite

schists. Large, spectacular but corroded chiastolites are exposed on weathered bedding faces. Interference-folding produces a ripple-marked effect. No scree is developed. Rare large corroded crystals also weather out of a highly graphitic schist at Locality 14, 6 km to the east.

Kalabity (Locality 15)

At Locality 15, on the low hills west of "Kalabity" shearers' quarters, stratigraphically equivalent chiastolite-bearing schists outcrop. The original screes are largely denuded, being so close to habitation. However, chiastolites may be found in nearby gullies which have received less attention. This locality is believed to be the Pootharingla Well locality described by Mawson, before Kalabity H.S. was built.

Waukaloo

The northern extension of the chiastolite schist horizon is truncated unconformably by overlying Adelaidean metasediments, and reappears to the northeast in the core of the Waukaloo syncline. The hill at Locality 16 has not been examined by the writer, but is believed to consist of chiastolite schists, as chiastolites occur in the thin scree across plains immediately to the south.

Dome Rock-Wiperaminga Hill

Chiastolites also occur near the shafts and buildings of the Dome Rock copper mine, and near outcropping iron formation (Locality 17). Mawson (1926) describes the chiastolites as ... "up to 9 cm in length and 2.5 cm across (with).. in section a good white cross." Stress during growth has produced fishtail forms and curved the arms of

the internal cross (see also Blissett, 1975; Dickinson, 1942) Most of the Dome Rock chiastolites have been altered to a greasy-looking pinite. Some show intermediate stages in the conversion with the central, unaltered pink zone being surrounded by white pinite.

At Wiperaminga Hill (Locality 18) (Robertson, 1972), chiastolites are spectacularly developed in rocks adjacent to feldspar quarries. Altered rims and unaltered cores, similar to those of the Dome Rock chiastolites have been observed . Detrital screes may be present in the steep gullies draining the northwestern flank of the ridge.

Old Boolcoomata to Olary

Two localities occur within a more structurally disturbed area, in contrast to the structurally simpler areas on Kalabity. Near Putt Well, Locality 19, "clinkery", dark, carbonaceous schists contain small chiastolites up to 5 cm long and 1 cm across. In the vicinity of the Black Maria mine, Locality 20, similar crystals occur beside a brown knotted andalusite schist and dark, slaty metasiltstones which are occasionally extremely graphitic, as at the Black Maria mine.

Graphitic and pelitic schists occur also near Ameroo Hill (Locality 21) and Mt. Perseverance (Locality 22). These localities, have not been examined but chiastolites are expected to be present.

SUMMARY

At several localities in the Willyama Complex, akin to

the classic Mt. Howden, large, well formed chiastolites weather out to produce screes. Elsewhere, numerous large, corroded chiastolites, large angular andalusites or small well formed chiastolites occur embedded within the country-rock but do not weather out to form significant accumulations.

Specimen material and stones suitable for cutting as ornamental stones are not confined to the previously recorded sites of Mawson (1911, 1926) such as Mt. Howden and Kalabity, which have been considerably denuded. The schist within which chiastolites are found is essentially a continuous, discrete unit within the Willyama Complex, and detailed traversing of this schist may locate further areas of well formed crystals.

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FIGS. 7 & 8

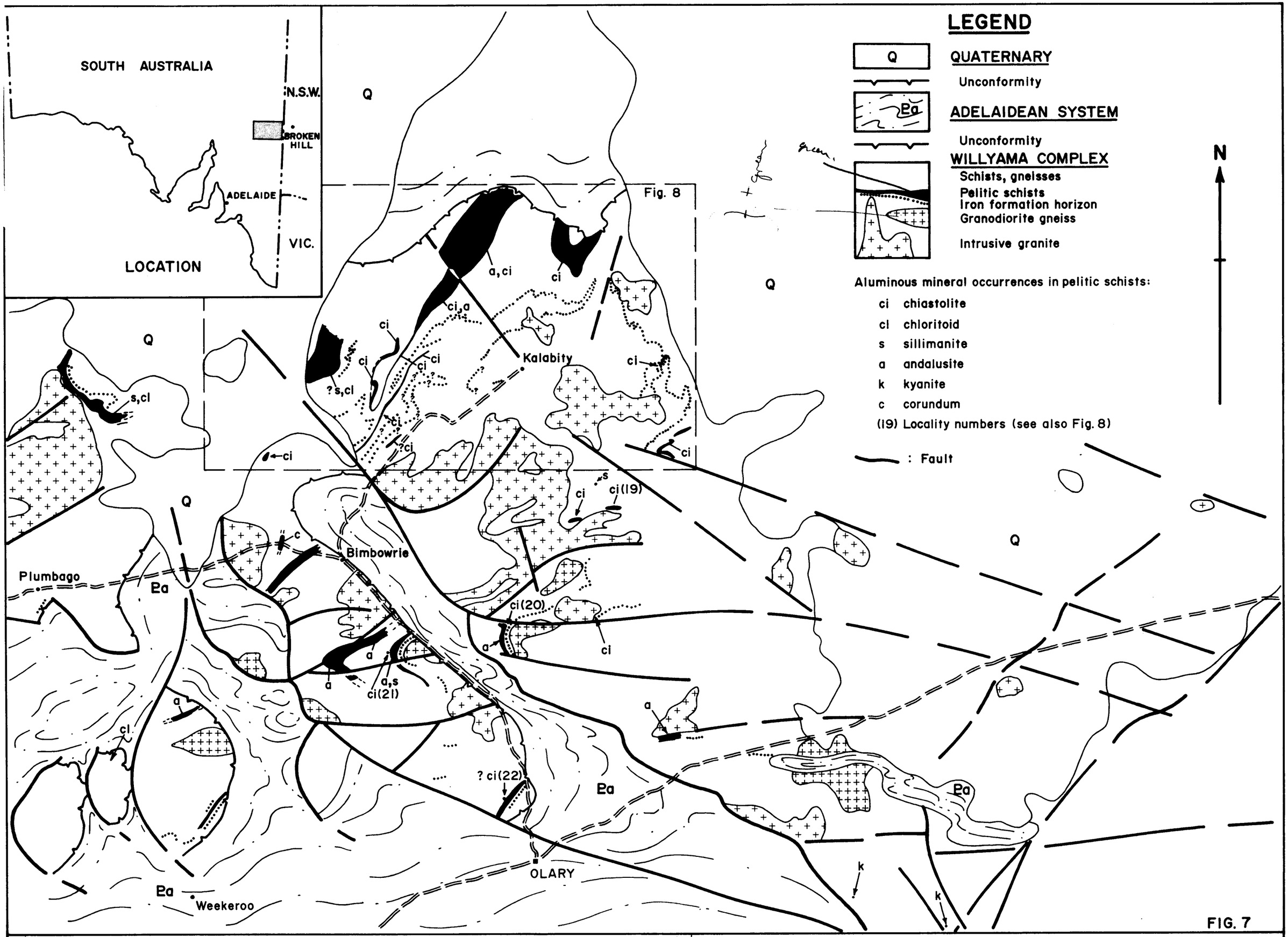

FIG. 7

Reduce to 500 000

SCALE: 1:250,000

5 0 5 10 15 20 25

KILOMETRES

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE: 1:250,000
COMPILED: G. PITT	NORTH-EASTERN WILLYAMA COMPLEX REGIONAL GEOLOGICAL STRUCTURE SHOWING OCCURRENCES OF ALUMINOUS MINERALS	DATE: OCT. 78
DRN: M.W. CKD:		PLAN NUMBER 78-818

Job No 960

LEGEND

PROTEROZOIC

upper

Pa — ADELAIDEAN SYSTEM (700-800 m.y.)
(Umberatana Group – no outcrop shown)

Unconformity

Intrusive granite (1500-1550 m.y.)

WILLYAMA COMPLEX (ca. 1700 m.y.)
Semipelitic schists and quartzites

Pelitic schists

Semipelitic schists and quartzites

Albitic and calc. silicate marker horizons; marbles at Mt. Howden

Iron formation and equivalents

lower

Schists

Higher grade schists, gneisses and migmatites

⚒: Pegmatite quarries

15: Locality numbers (see also Fig. 7)

N

Curnamona H.S.

Strathearn H.S.

Pa

Nankeeta Hill

13

14

16

Callico Creek

Waukaloo

12

11

9

Bimba Mine

10

8

Mt. Howden

7

6

5

4

3

2

1

Alconie Hill

KALABITY H.S.

WOOLSHED

15

Dome Rock

17

Wiperaminga Hill

18

Olary

FIG. 8

SCALE: 1:63,360

0 1 2 3 4 5 6 7 8 9 10

KILOMETRES

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE: 1:63,360
COMPILED: G. PITT	KALABITY 1:63,360 SHEET SIMPLIFIED GEOLOGY LOCALITIES OF CHIASTOLITE OCCURRENCES	DATE: OCT. 78
DRN: M.W. CKD:		PLAN NUMBER 78-819

No. 960