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AUSTRALITES FROM GINDALBIE AND MENANGINA PASTORAL STATIONS, WESTERN AUSTRALIA

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ABSTRACT

The Tonkin australite collection from Gindalbie and Menangina Pastoral Stations, Western Australia differs from other samples collected in the Eastern Goldfields region. Most differences can be ascribed to a small content (several percent) of australites from a small area where they had been protected from weathering and erosion during much of their terrestrial residence by shallow burial. Australites from that area (The Patch) are largely forms which consist partly or wholly of secondary glass (56.6%), lens-forms (33.3%) and cores (6.1%). The cores/lens-forms ratio is only 0.18. This material provides an insight into the likely constitution of the australite population immediately after arrival on the earth's surface.

INTRODUCTION

Gindalbie and the adjoining Menangina Pastoral Stations are centred about 30°S, 122°E, 100 km north-north-east of Kalgoorlie in the Eastern Goldfields of Western Australia. Access from Kalgoorlie is via Kanowna or Comet Vale (Figure 1).

The region has very low relief and the climate is semi-arid with mean rainfall about 210 mm/a. Drainage is internal to salt lakes. Lake Marmion, so-called "Boomerang" Lake on Menangina Station and Lake Rebecca are members of a chain of salt lakes occupying the partly choked and much modified, old age valley of a river system dating from more humid times, but now draining to south-east only after rare heavy rains.

Australites occur on the surface of the ground, especially where gravelly drifts have accumulated, in rain-wash gutters and on the margins of the salt lakes. A small area 10.5 km in direction 95° from Menangina homestead discovered by Mr R. McMeekin in 1970 is exceptional in that australites were thinly covered some time after fall by sand which became fixed by vegetation. They are now being released, a process hastened by grazing sheep. The australites from this small area, which will be designated by its colloquial name of "The Patch", include some fully flanged forms and others which are unusually small or frail for an area with such a harsh climate (Cleverly 1973).

The purpose of this paper is to describe the features of australites found on Gindalbie and Menangina Stations and to account for any peculiarities compared with other australites from the region. The largest sample available is the collection of Mr S.J. Tonkin, but as that collection is known to contain some australites from The Patch, it was desirable that further samples be examined from each of The Patch and from those parts of the stations outside it. The contributions of each to the Tonkin collection could thus be assessed. In the event, as explained in more detail below, it was not possible to obtain an acceptable sample for the country outside The Patch, and regional average figures were used instead.

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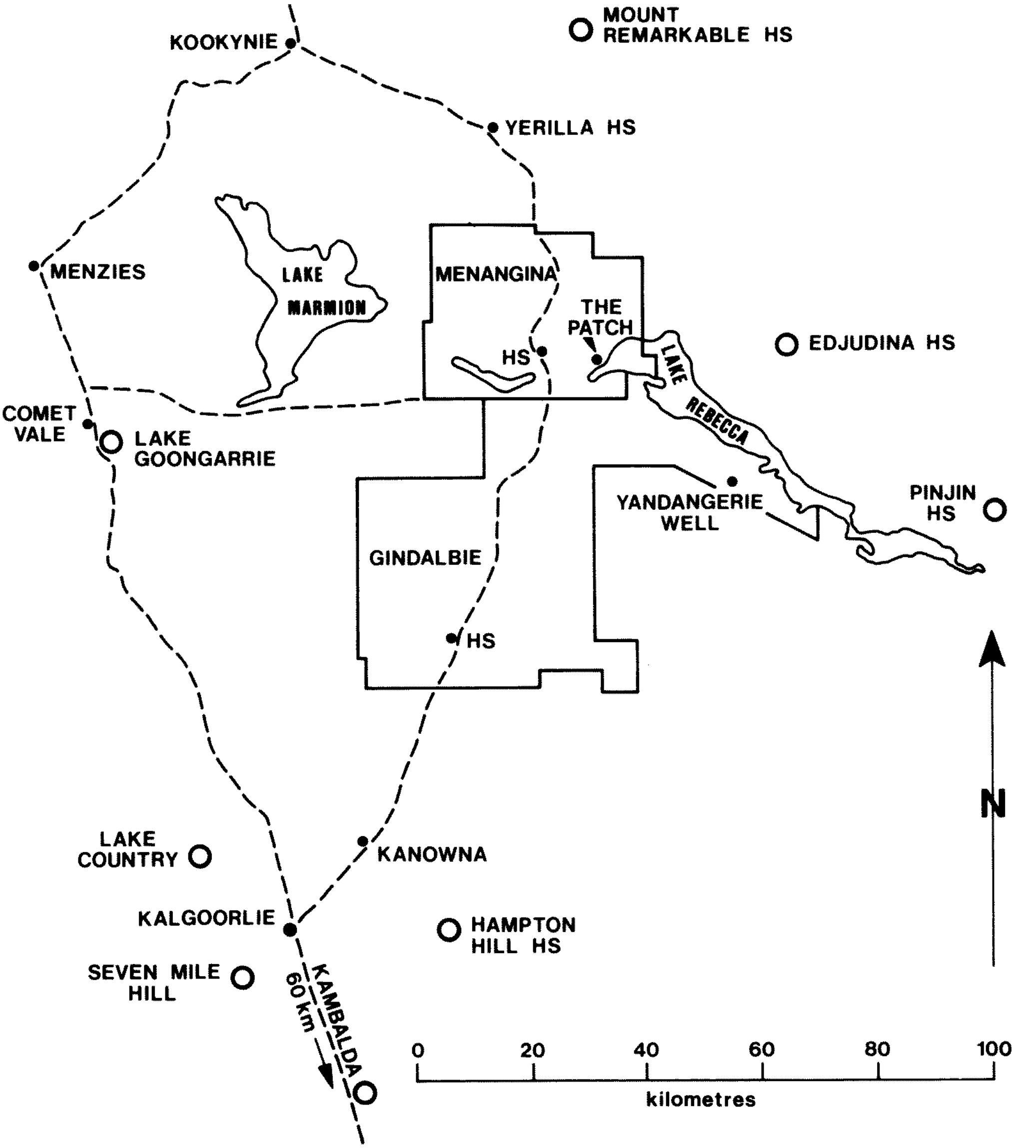

Figure 1 Map of Gindalbie and Menangina Pastoral Stations. Open circles are focal points of areas from which previous samples have been examined.

MATERIAL AND PROCEDURE

Sample 1 is the private collection of 1876 australites assembled by Mr S.J. Tonkin and family, formerly of Menangina Station. The Menangina component of the collection includes some specimens from The Patch. Many australites were collected from the fringe of Lake Rebecca north of Yandangerie Well on Gindalbie Station, and in recent years, Mr S.F. Tonkin and family have contributed further specimens from that station. Although small forms such as bowls in this sample were most likely found in The Patch, there is less certainty of attribution for larger forms such as cores. Thus the australites found in The Patch cannot be separated with confidence from those found outside it.

Sample 2 comprises 173 australites from The Patch in the Western Australian School of Mines collection. This sample is made up of the small numbers of australites released from the sand from time to time, especially after sporadic thunder-storms. It is the product of numerous close searches at intervals over more than 22 years, but is still numerically somewhat inadequate. The several hundred australites collected by the McMeekins following their discovery of The Patch are not available.

Samples 1 and 2 were classified morphologically and weighed. Extracts from the statements of morphology and weight are presented in Table 1. The system of classification and procedure are those of Cleverly (1986).

An additional 265 australites from Gindalbie and Menangina Stations dispersed in 8 collections other than the Tonkin collection were examined, but it was not possible to assemble a sufficiently large and representative sample for parts of the stations outside The Patch. The several reasons for rejection include insufficiently specified localities and unacceptably high numbers of australite flakes which are probably Aboriginal artifacts (34/59 specimens in one collection, 14/37 in another). Instead of a third sample, regional average figures were calculated (Table 1) from samples previously examined (Cleverly 1986, 1988a, 1990, 1991b, 1992). These samples were gathered from areas which encircle Gindalbie and Menangina Stations (Figure 1) and the average figures should therefore provide a norm by which Samples 1 and 2 may be judged.

The specific gravities were determined by loss of weight in pure toluene at measured temperature for 66 australites taken at random from 139 specimens from The Patch, *i.e.* from the 173 specimens of Sample 2 less the 34 specimens for which values had been determined previously (Cleverly 1973). Thus 100 values were available for australites from The Patch.

The specific gravities were determined also for 45 specifically located australites from Gindalbie Station taken at random from the 109 available in the Tillotson private collections. Together with 300 previous determinations (Cleverly 1988a, 1990, 1991b), 345 values were thus available for the country surrounding The Patch.

MORPHOLOGY OF AUSTRALITE SAMPLES

Most of the important differences between Sample 2 (The Patch) and regional average (Table 1, columns 2 and 3) can be ascribed to burial-preservation. The differences include:- the higher percentage of whole forms; the higher percentage of incomplete but classifiable forms, and thus the total of classifiable forms in Sample 2 (items 1, 2 and 3 of Table 1); the higher percentage of aberrant forms (item 13), for example the lens with anomalously transverse flow ridge would be unrecognisable as aberrant if abraded; the extremely high percentage of forms consisting wholly or partly of secondary glass (items 14 plus 15), as these

Table 1 Morphological features and mean weights of australites. Sample 1, Tonkin collection from Gindalbie and Menangina Stations. Sample 2, School of Mines collection from The Patch on Menangina Station. Regional mean and standard deviation for eight samples from the region from Cleverly (1986, 1988a, 1990, 1991b, 1992).

Item		Sample 1	Sample 2	Regional Mean	Regional S.D.
1	Whole forms or essentially so %	37.8	44.5	38.2	9.5
2	Incomplete but classifiable %	16.4	16.8	12.8	2.2
3	Total classifiable %	54.2	61.3	51.0	9.8
4	Fragments and indeterminate %	40.8	38.1	47.9	9.9
5	Flakes and flaked cores %	5.0	0.6	1.1	1.1
6	Round forms %	67.4	48.5	69.0	7.9
7	Broad oval forms %	7.7	24.2	8.2	3.5
8	Round plus broad oval forms %	75.1	72.7	77.2	4.6
9	Narrow oval forms %	7.4	7.1	7.6	2.0
10	Boat forms %	3.0	6.1	5.1	0.8
11	Dumbbell forms %	11.0	11.1	7.2	1.5
12	Teardrop forms %	3.4	3.0	3.0	1.7
13	Aberrant forms as % of classifiable	2.9	6.6	3.0	0.9
14	Flanged, disk and plate, bowl and canoe forms %	2.2	50.5	2.4	3.0
15	Indicators I %	5.0	6.1	1.7	1.4
16	Lens-forms %	57.1	33.3	60.4	11.1
17	Indicators II %	1.8	4.0	1.2	1.1
18	Cores including conical %	33.8	6.1	34.2	11.0
19	Cores/lens-forms ratio	0.59	0.18	0.61	0.27
20	Number of whole australites	709	77		
21	Mean weight of whole australites (g)	2.93	1.64	2.75	1.07
22	Total number of specimens	1876	173		
23	Mean weight of all specimens (g)	2.01	1.16	1.87	0.57
24	Number of shape types in sample	36	32		

forms are either frail or have weakly attached secondary features; the low percentage of lens-forms (item 16) and very low percentage of cores (item 18) as these are developed largely as a result of weathering (Cleverly 1986) and become eventually the predominant forms as at Goongarrie (Cleverly 1991b); the low cores/lens-forms ratio (item 19), since cores are the ultimate weathering product; the low mean weights (items 21 and 23), which follow from the abundances noted above *viz.* numerous small bowl and similar forms, fewer lens-forms than usual and even fewer cores.

One of the most distinctive features of Sample 2 is the high number (32) of shape types represented in a collection containing only 106 identifiable specimens (item 24). In general, the number of shape types in a sample from the semi-arid zone increases slowly with the numerical size of the sample (Figure 2). A perusal of published statements of morphology shows that in areas of severe erosion the odd specimen of some small or frail type will survive, possibly favoured by some special localized circumstance, and the chances of survival increase with the size of the sample. Even in the harsh conditions of Lake Yindarlgooda on Hampton Hill Station the high number of 35 shape types was represented, but the sample was of 21 927 specimens (Cleverly 1986). Seven of the shape groups in that sample were

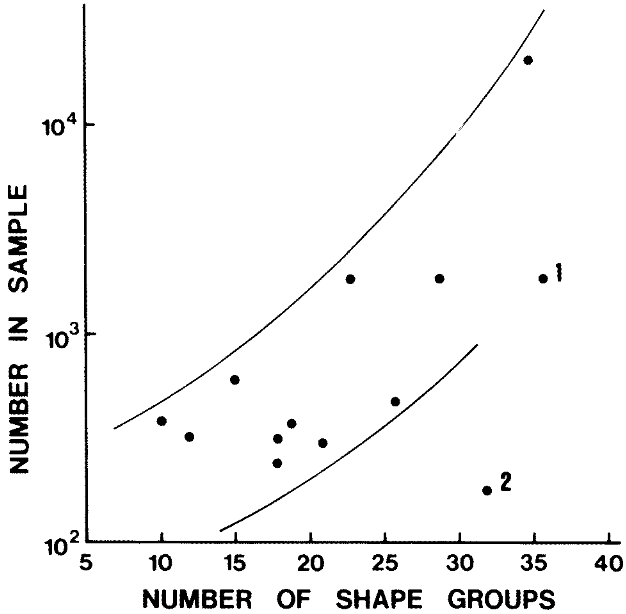

Figure 2 Scatter diagram illustrating general slow increase in number of shape groups represented with numerical size of australite samples from the semi-arid region (data from Cleverly 1986, 1988a, 1990, 1991a, 1991b, 1992). Numerals 1 and 2 indicate Samples 1 and 2 of this paper.

represented by single specimens *i.e.*, each of those groups comprised less than 0.01% of the 10 913 classified australites. Samples from the country surrounding Gindalbie and Menangina Stations plot within the general trend zone (Figure 2), but Sample 2 is uniquely isolated outside it.

The unusual australite morphology in The Patch influences Sample 1 (compare columns 1 and 3, Table 1). These influences include:- the higher percentage of classifiable forms in Sample 1 (item 3); the abundance of dumbbell forms; the lower total percentage of lens-forms (item 16) and cores (item 18), total 90.9% compared with 94.6% for the region (the inclusion of 7% of specimens from The Patch could account for this low figure); the very high number of 36 shape groups which thus plots marginally to the general trend (Figure 2). Sample 2 contains 11 shape groups which are not represented in Sample 1. The inclusion of a quantity equal to Sample 2 (173 specimens or 9%) in Sample 1 would probably have been adequate to account for the high number of shape groups present.

Some minor differences, between Sample 1 and regional average cannot be attributed to inclusion of australites from The Patch. The abundance of flakes and flaked cores (item 5) is a feature of the general area which includes Aboriginal occupation sites such as McAuliffe Soak, Carr Boyd Rocks and Cane Grass Waterhole (Cleverly and Cleverly 1985). The mean weights (items 21 and 23) are a little higher than regional average despite the presence of australites from The Patch. High mean weights are probably also a feature of the general area as they are yet higher in the Mount Remarkable area to the immediate north (Cleverly 1988a).

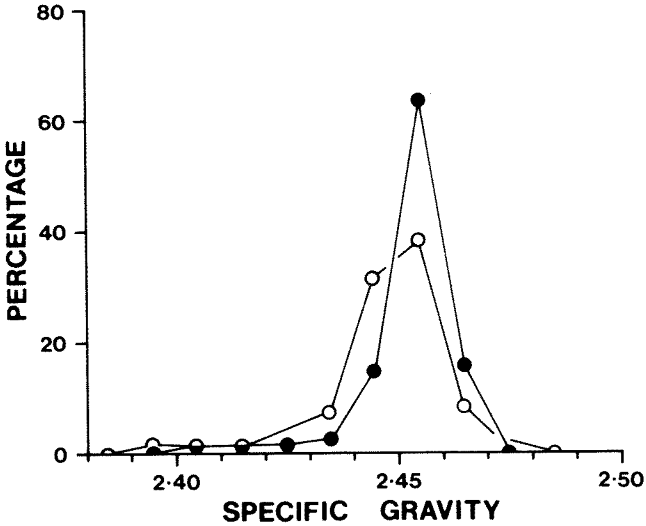

Figure 3 Frequency polygons of specific gravity for australites. Open circles: sample of 100 australites from The Patch on Menangina Station. Filled circles: composite sample of 345 australites from country surrounding Gindalbie and Menangina Stations. Simplified slightly for specific gravity values less than 2.43.

SPECIFIC GRAVITY

Numerous australites in Samples 1 and 2 show breached bubble cavities in the range 1-10 mm diameter. A few fragments suggest rare larger cavities. When a population of australites containing randomly distributed bubble cavities is reduced in size by weathering and erosion, one result is the greater spread of specific gravity values (Cleverly 1988b). The situation at Menangina is rather the reverse. Small and frail australites have survived in The Patch but most of them have been eliminated from the surrounding country. Thus the outside population tends increasingly to larger specimens which are more representative samples of a heterogeneous material and closer to average. The specific gravity frequency diagram therefore shows a larger modal percentage and smaller spread of values than for Sample 2 from The Patch (Figure 3).

The weighted mean specific gravity for 100 specimens from The Patch is 2.451 and for 100 from outside it is 2.452. The closeness of those means is taken to confirm the opinion (Cleverly 1973) that Sample 1 derives from the same regional population, now seen after different conditions of preservation.

NOTES ON SOME INDIVIDUAL SPECIMENS

Some larger australites from Gindalbie and Menangina Stations are illustrated in Figure 4. For some small forms, see Cleverly (1973).

The flanged oval (Figure 4D-F) has faintly etched, radial, secondary schlieren on the anterior surface which are just visible in oblique illumination. These schlieren are much less evident than on the "well preserved" buttons from Victoria figured by Baker (1967). Thus the oval is less severely weathered than the buttons.

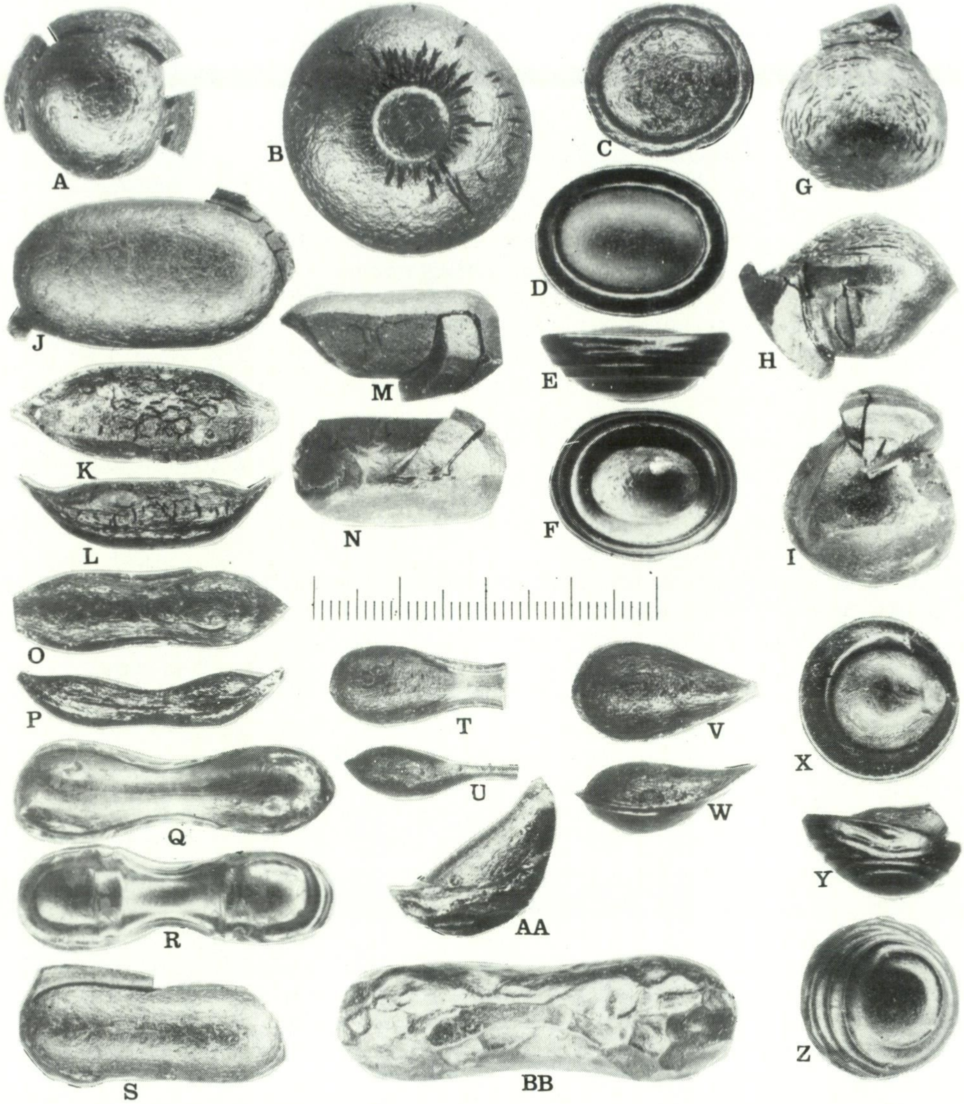

Figure 4 Australites from Gindalbie and Menangina Stations (except X, Y and Z). PS indicates posterior surface of flight, SE side elevation, AS anterior surface. SM - the W.A. School of Mines collection, T - the Tonkin private collection. Scale: centimetres and millimetres. A: PS of round indicator II, T. B: PS of round core with central bubble crater and radiating v-grooves with divided ends, T. C: PS of flanged broad oval, elongation 1.13, T. D, E and F: PS, SE and AS of flanged broad oval, elongation 1.27, private collection of W.R. Moriarty. G, H and I: PS, end elevation and AS of broad oval indicator II, SM. J: PS of narrow oval indicator I, T. K and L: PS and SE of boat-canoe, SM. M and N: SE and AS of boat-indicator II with emergent wedged core, SM. O and P: PS and SE of dumbbell - canoe, SM. Q and R: PS and AS of dumbbell-indicator I, T. S: PS of dumbbell - indicator I, SM. T and U: PS and SE of broken dumbbell-lens ex canoe, waist centre 0.8 mm thick, SM. V and W: PS and SE of flanged teardrop, SM. X, Y and Z: PS, SE and AS of flanged teardrop, Motpena, S.A., Univ. Adelaide collection. AA: SE of flanged teardrop, SM. BB: Aberrant dumbbell, orientation indeterminate, T.

One cause of variability in teardrop forms is the degree of tapering of the primary apioid, which influences the angle of inclination of the apioid axis to the line of flight during ablation stripping. An australite formed from a gently tapering apioid (Figure 4V,W) has narrow flange, too undeveloped to be backwardly rolled, and typical teardrop shape. Another example formed from a bluntly tapered apioid was oriented more steeply with a circular section normal to the line of flight. It resembles a button, but with a remnant of the apioid within the circular, backwardly curled flange instead of a remnant of sphere or oblate spheroid. A South Australian example has been illustrated (Figure 4X-Z) instead of the incomplete one from The Patch. A third variant of the flanged teardrop is shown in Figure 4AA.

The dumbbell-shaped aberrant form (Figure 4BB) resembles certain dumbbells from south-east Asia in having no defined zone of ablation or stress shell loss, and hence no evident flight orientation. There is an overall coverage of dimpled flow ridges.

CONCLUSIONS

The important differences between the Tonkin australite collection from Gindalbie and Menangina Stations and samples from the surrounding Eastern Goldfields region are accountable to a small content of australites from an area where they had been protected from destructive processes by shallow burial.

A sample of australites from that small area and a consideration of the changes which have occurred to australites in the region outside it provide an insight into the likely constitution of the australite population immediately following arrival on the earth's surface. The australites were probably predominately forms consisting of secondary glass (such as certain bowls) or having attached secondary glass (such as flanged forms). Lens forms would be poorly represented compared with present populations, being principally those small ones formed by loss of flange late in ablation flight. Cores would be even more poorly represented, being formed only from the few secondary bodies large enough to lose the stress shell spontaneously while cooling. Impact may have resulted in minor contributions to indicators I and lens-forms by damage to or loss of flanges, and contributions to indicators II and cores by fracturing of stress shells. The cores/lens-forms ratio was very low. Aberrant forms were more numerous and varied than they are now. The mean weight of complete forms was probably not much more than one gram.

Subsequently, weathering and the slow changes summed up by Cleverly (1986, Figure 3) have reduced the proportion of forms with secondary glass, sometimes to vanishing point, and increased lens-forms and ultimately cores to become the predominant forms (total 86.5% to 100% in Eastern Goldfields samples). Thus australite samples from the region are very poor representations of the original population.

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