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FURTHER LARGE AUSTRALITES FROM WESTERN AUSTRALIA

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ABSTRACT

Australites which weigh individually more than 100 g and have become known since 1974 have been listed and described if that has not already been done. The sites of find conform to the previously established pattern which may have significance in terms of australite origins and dispersal.

INTRODUCTION

In an earlier paper (Cleverly 1974), the 32 known Western Australian australites which each weighed more than 100 g were described or references were given if adequate published descriptions already existed. Eight further specimens are now known. Two are in the Western Australian Museum (WAM), one in the Geology Department, W.A. School of Mines, and five in private collections. The purpose of the present paper is to up-date the earlier one according to the same general plan. Some physical details of the additional specimens are given in **Table 1** and their sites of find are shown in **Fig. 1.** Notes on individuals follow in the numerical sequence of the table.

DESCRIPTIVE NOTES

1 Private collection of Mr A. McConnell of South Australia. For a detailed description and illustrations see Scrymgour (1978).

2 **Fig. 2A-D.** Owned by Mr L.G. Lewis of Corrigin, who found it in a dry creek bed on Avon Location 21 846 (property of Mr H. Button) on 3 August 1977.

The posterior surface of flight shows a number of smooth flow cells separated by narrow widths of highly vesicular glass with strong flow

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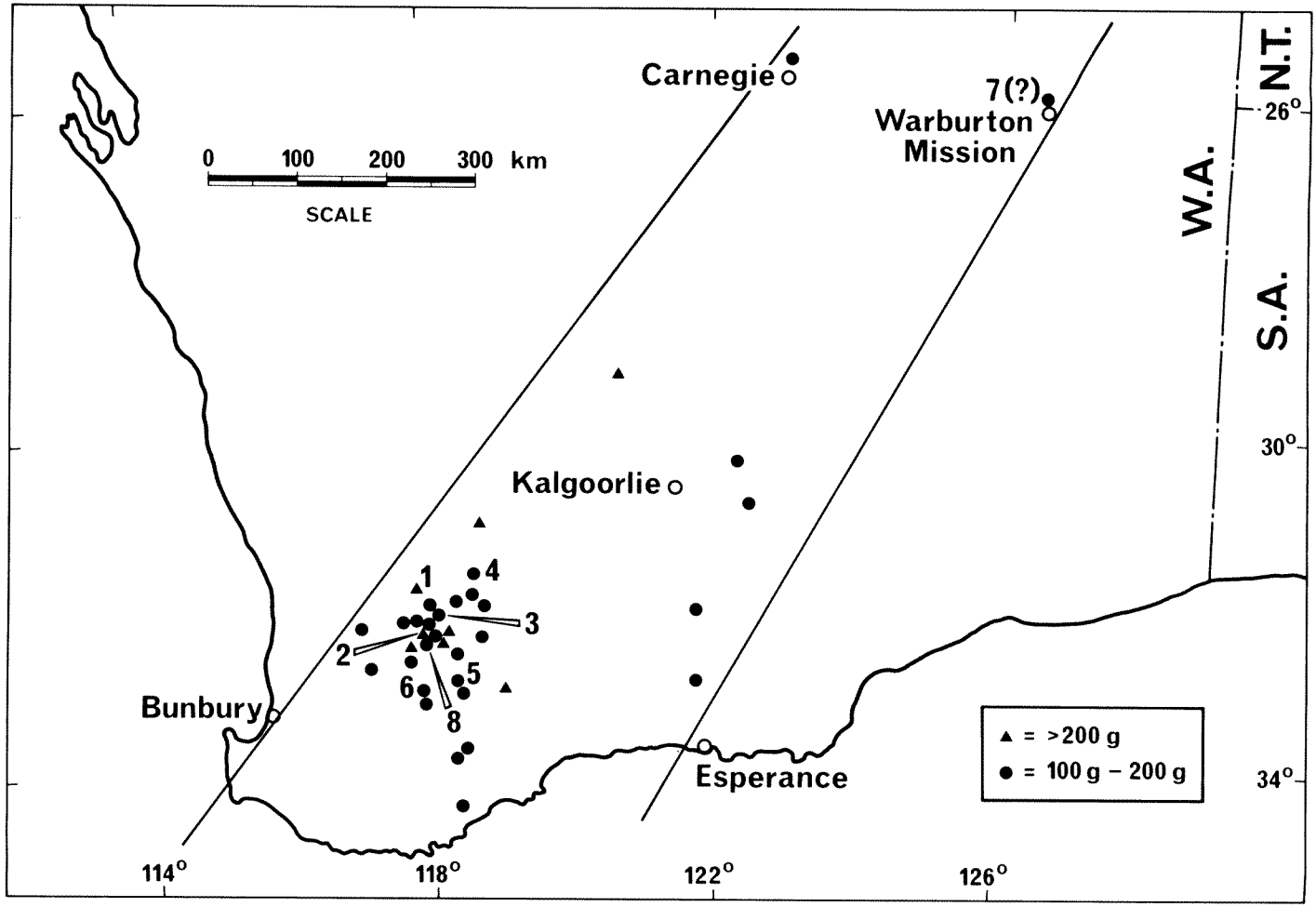

Fig. 1: Map of southern Western Australia showing the sector containing sites of find of australites weighing more than 100 g. Numbers refer to the australites of Table 1.

TABLE 1

Masses and dimensions of some large australite cores from Western Australia and their primary bodies.

			Australite					Primary body		% Losses	
No.	Core shape	Site of find	Long. E	Lat. S	Mass g	Dimensions mm	G	Dimensions mm	Mass g	Mass	Depth
1	[1]Teardrop	Near Shackleton	117°15'	31°56'	225.07	66.0 x 57.0 x 50.1	2.42	...	...		
2	Round	7 km S of W of Gorge Rock	117°55'	32°28'	200.53	(60.0-57.7) x 51.2	2.375	66 diameter	365	45	23
3	Round	10.5 km SE of Babakin	118°07'	32°11'	197.35	(58.7-57.0) x 48.6	2.426	66 diameter	375	47	27
4	[2]Broad oval	6 km E of Muntadgin	118°37'	31°46'	167.98	69.9 x 56.9 x 35.2	2.428	77 x 62 x 40	245	31	12
5	Round	Lake Grace	118°28'	33°06'	132.73	(53.8-52.7) x 39.1	2.424	—			
6	Round	*ca* 16 km SSE of Harrismith	*ca* 117°56'	*ca* 33°04'	121.40	(49.6-48.6) x 39.9	2.423	*ca* 55 diameter	210	42	27
7	Narrow oval	Warburton Range area (?)	*ca* 126.5°	*ca* 26°	110.12	67.4 x 39.5 x 30.1		...	...		
8	[3]Fragment	6 km SW of Gorge Rock	117°57'	32°31'	80.09	55.2 x 40.3 x 29.6	2.428	—	—	...	

[1] Data from Scrymgour (1978).

[2] Data from Cleverly (1979).

[3] Of round or broad oval core initially weighing more than 100 g.

structure (**Fig. 2A**). The rim is somewhat rounded by weathering and is irregular in the plan view, though quite planar (**Fig. 2A-C**). The equatorial zone shows a few shallow, spiky-outlined depressions from which thin flakes have been lost as described below for the anterior surface. The main anterior surface is very oblique to the line of flight (**Fig. 2C**), evidently as the result of an old loss of some tens of grams of material. The scar is now characterized by a roughly concentric system of cracks and by small depressions, not generally more than 0.5 mm deep, resulting from the loss of small flakes with spiky outline. The origins of those minor features are unknown. Rather similarly-shaped small depressions are present along the course of U-grooves on the anterior surface of a large round core from Lake Yealering, Western Australia (Chapman 1964, Fig. 6A), but they appear to be the result of corrosion rather than of flake loss.

The specific gravity is only 2.375, the lowest value found for any of the large cores from southwestern Australia. For 31 such cores (Cleverly 1974 and this paper), the mean specific gravity is 2.426 with standard deviation 0.008; the very small standard deviation is noteworthy. All the values except the one under consideration are in the narrow range 2.409 to 2.439. The most likely explanation for the unusually low specific gravity of this specimen is the presence of a bubble cavity or cavities. An australite of this size and of average specific gravity 2.426 would need a bubble cavity of volume 1.8 cm^3 (diameter 15 mm) to reduce the bulk specific gravity to 2.375. For stability in flight, such a large cavity would have to be centred, at least approximately, upon the line of flight and closer to the posterior than to the original anterior surface of flight. No cavity could be detected using strong lamps but that is not surprising in view of the extremely large size of the australite. The dimensions of the specimen are such that a 15 mm bubble could be enveloped in glass as much as 18 mm thick. Complete australites which are known to contain a cavity as

large as 15 mm diameter are extremely rare (Baker 1966, Table 1), but specimens with breached cavities of that size and fragments of such specimens are occasionally found. The presence of a bubble cavity, even if of unusually large size, is still a more likely explanation than that the specimen should be radically different in its chemistry and hence in its specific gravity from others found in the same general area, or that it should be an import to the area.

3 **Fig. 3A & B.** WAM 13 364. Found by Mr Tony Hobson some years prior to 1975 on Avon Location 18 941 about 1.2 km in direction 120° from its northwestern corner. Donated by Mrs L. Robins.

The specimen is classed as a round core but has considerable irregularity of shape arising from peculiarities of the detached stress shell. In one area (**Fig. 3A**) a tongue of glass remains anterior to the rim where it would normally have been detached as stress shell; in another area distant about 120° around the rim (**Fig. 3B**), spalling has extended far posterior to rim level, almost to the posterior pole.

The most prominent minor sculpture is the grooves of U-shaped cross section on the equatorial zone and anterior surface. Grooves near the rim have their usual orientation approximately normal to it and are present also around the outside of the tongue of persistent stress shell and around the inside of the spalled embayment on the posterior surface. This distribution of grooves supports the interpretation that those features are parts of the outline of a stress shell of unusual shape.

The estimates of the form of the primary body and losses from it (**Table 1**) are necessarily not of the highest quality for such an irregularly shaped specimen.

4 WAM 13 396. For a detailed description and illustrations, see Cleverly (1979a).

5 Private collection of Mrs A. Clarke of Cottesloe, Western Australia.

As in the case of no. 3 above, there are imperfections of shape arising from peculiarities of the stress shell. The rim is recognisable and regular for most of the circumference, though very much reduced and affected by solution etching. Around rather more than half the circumference, thin flake losses extend from c. 5 mm to c. 20 mm posterior to rim level (**Fig. 3C & D**). The flaked zone, like the anterior surface (**Fig. 3E**), shows a very abundant development of U-grooves. Curves could not be fitted sufficiently closely to the posterior surface to warrant the calculation of a primary body.

This specimen is one of those cores found especially in south-western Australia which 'exhibit a base surface that is irregularly contoured, often somewhat faceted in shape' (Chapman 1964, p. 852). Specimen no. 3

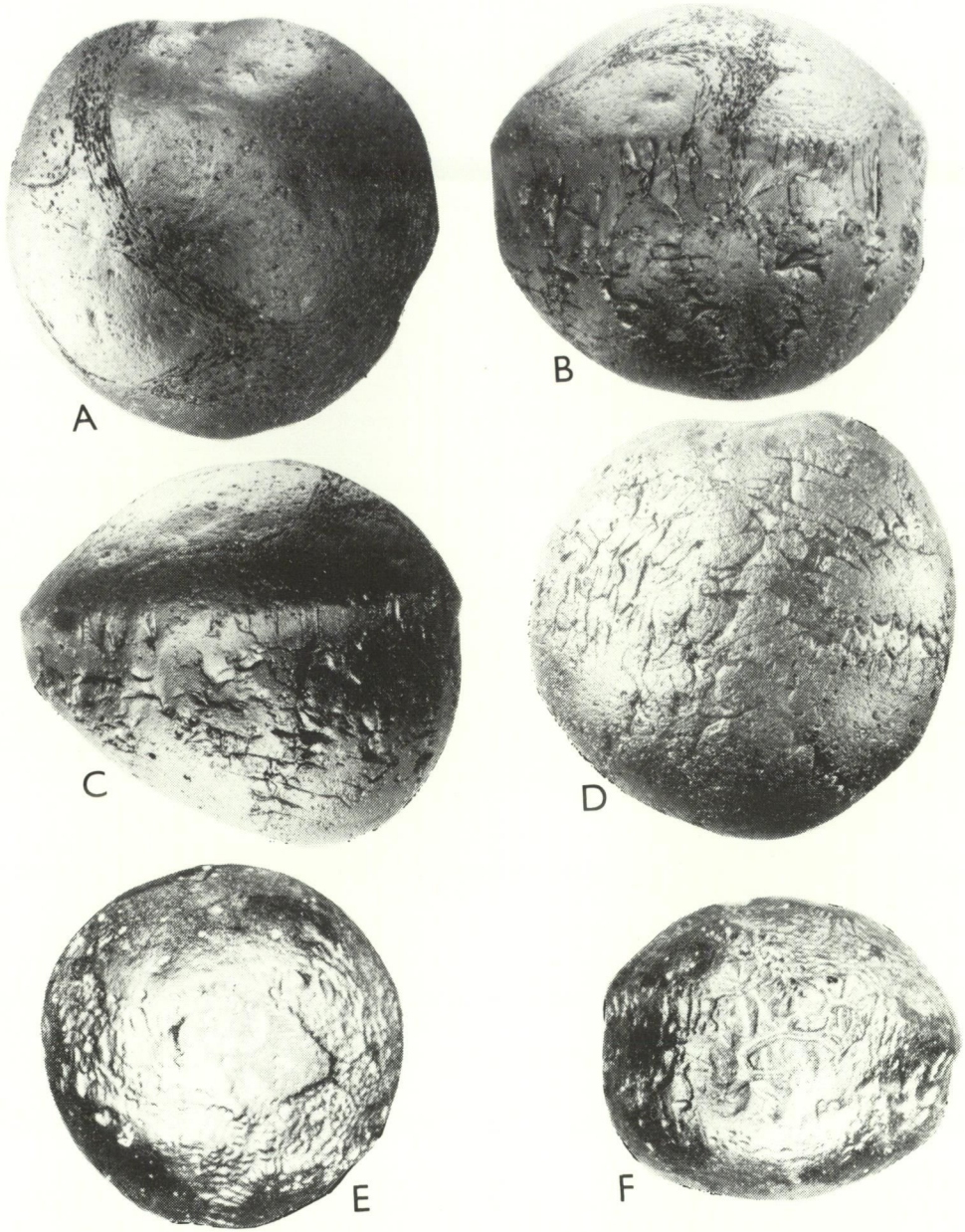

Fig. 2: Large australites from Western Australia. Natural size. For key to specimen numbers, see Table 1. In elevational views, direction of flight is towards bottom of page. A: No. 2, posterior surface of flight. B: No. 2, elevation. C: No. 2, elevation showing obliquity of part of anterior surface to line of flight. D: No. 2, as seen in a direction normal to the oblique part of the anterior surface, rim at top. E: No. 6, posterior surface showing abundance of minor sculpture where thin flakes have been lost. F: No. 6, elevation.

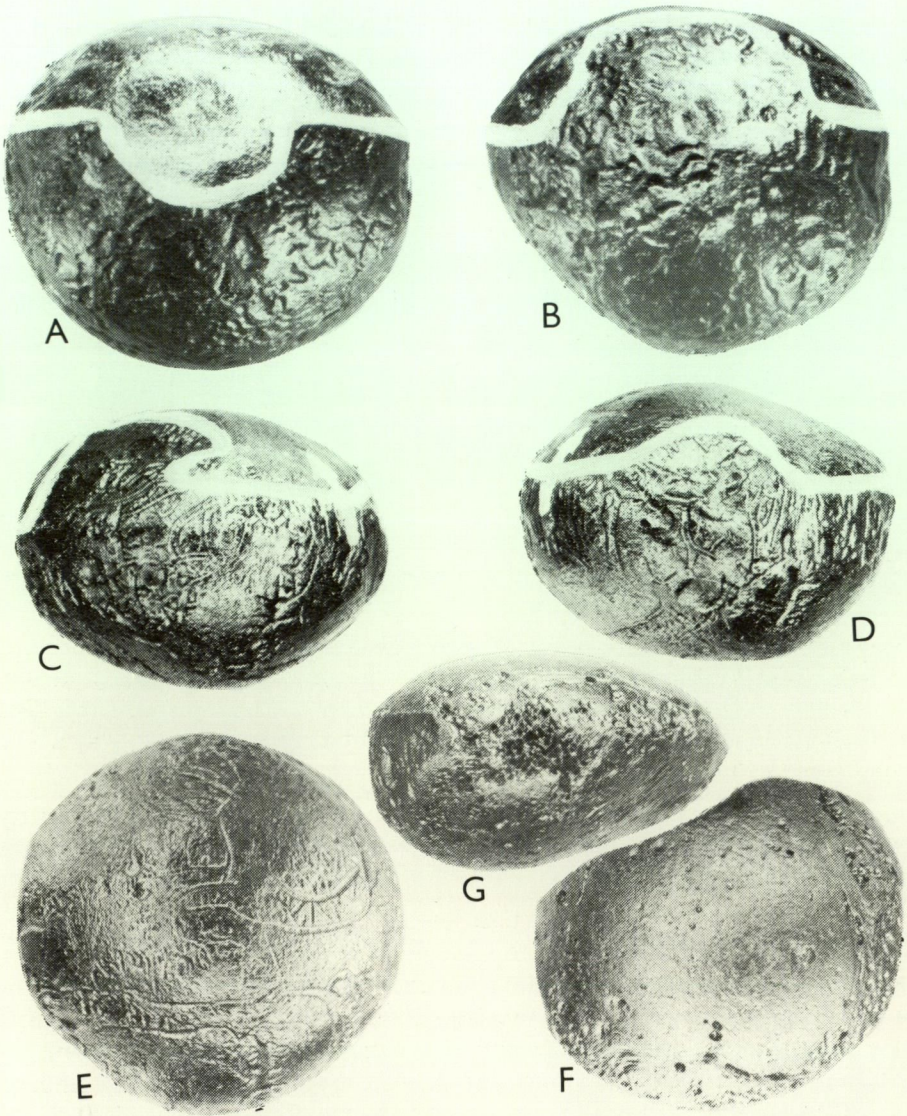

Fig. 3: Large australites from Western Australia. Natural size. For key to specimen numbers see Table 1. In elevational views, direction of flight is towards bottom of page. A: No. 3, elevation. White line marking rearward limit of spalling coincides with rim at left and right. B: No. 3, a second elevational view. C: No. 5, elevation. White line marking rearward limit of spalling coincides with rim only at extreme left. Rim faintly visible across middle of photograph. D: No. 5, elevation to right of C (arrow is common to both views). White line, descends to rim level only at point of disappearance on far right. E: No. 5, anterior surface. F: No. 8, posterior surface. G: No. 8, elevation showing from left to right, old flake scar, highly vesicular area, rim.

above and no. 6 below are further examples. The abundant occurrence of U-grooves on the flaked zone posterior to the rim as well as on the anterior surface illustrates the relationship of the grooves to surface exposed by loss of stress shell as first pointed out by Chapman (*op. cit.*).

6 **Fig. 2E & F.** W.A. School of Mines Geology Department collection 12 030. Found in 1978 by Mr P.H. Davidson of Kukerin on Avon Location 11 996 which is located 16 km SSE of Harrismith towards Moulyinning.

The posterior surface of flight is extensively affected by old shallow flake losses (**Fig. 2E & F**). Estimates of the radius of curvature of that surface (i.e. of the primary body) show a considerable variation from 52.5 to 57.2 mm, and a rounded mean figure of 55 mm was used for the calculation of the primary body and the losses from it. The anterior surface is oblique to the line of flight because of a considerable loss of material.

The surface of the core is brighter anterior to the rim. This suggests that it was embedded in the soil for some time to the level of the rim with the posterior surface exposed to abrasion by blown sand whilst the balance of the surface was subject to etching by the chemical constituents of soil water.

7 Obtained from Aborigines at Warburton Mission by Mr S. Bridgeman, but it might have been brought into the Mission from a considerable distance. Enquiries continue regarding the specific provenance. The specimen could be examined only very briefly and the details shown in **Table 1** were the only observations possible.

8 **Fig. 3F & G.** Private collection of Mr L.G. Lewis of Corrigin. Found by Mr M. Winmar on a stony ridge on Avon Location 19 800 (property of Lewis Bros) in March 1979.

This fragment is the major part of a large core but is insufficiently complete for determination of original shape and mass with certainty. The core could have been round, of diameter *ca* 52 mm and mass *ca* 105 g or possibly broad oval *ca* 58 x 55 mm and mass *ca* 119 g. These are the limits of a number of attempted reconstructions which differ according to whether small differences in radii of curvature are regarded as original or attributed to weathering. The mass was probably more than 100 g and might have approached 120 g.

The rear surface is dominated by smooth flow cells with bordering glass having strong flow structure shown by etched schlieren, and numerous bubble pits including a small, highly vesicular area which interrupts the rim (**Fig. 3F & G**). The rim is well-defined, reasonably regular and planar. There is no defined equatorial zone. The anterior surface shows a few etch pits and shallow (i.e. abraded) U-grooves including some which are approximately normal to the rim.

Portion of an old fracture scar is etched quite as deeply as the major surfaces; it evidently dates from early in the terrestrial history of the core. The much larger fracture surface shows minute pits and lightly etched schlieren giving it a matte appearance. It is clearly a much younger fracture, yet appears too weathered to have been caused by man. There is no defined cone of percussion or other feature to suggest that the fragment is other than a natural one.

DISCUSSION

Two examples (nos 3 & 5) of extensive shallow flaking of posterior surfaces and one less evident example (no. 6) are present amongst the eight specimens; for other examples see Chapman (1964), who has offered an explanation. Three specimens (nos 2, 6 & 8) have lost large pieces from the anterior leaving the surface very oblique to the line of flight; another example is a round core of 92.9 g from Avon Location 19 123 between Muntadgin and Tandagin owned by Mr Brett Hooper of Muntadgin. No reason for these losses is known.

The criticism that too much attention has been paid to very large australites and too little to very small ones is defensible in Western Australia on two counts. Firstly because, with the possible exception of some specimens from Menangina, few small specimens from Western Australia are sufficiently well-preserved to warrant study (Cleverly 1979b). Secondly, because all australites weighing more than 100 g known to 1977 were found in two sectors divergent from northern Australia, the heaviest ones towards the southern ends and western sides of the sectors (Cleverly & Scrymgour 1978, Fig. 3); the specimens which have since become known conform to the pattern (Scrymgour 1978, Fig. 2; this paper, **Fig. 1**) with the possible exception of no. 7, the provenance of which is unknown. The pattern might well have significance in regard to australite origins and dispersal. For example, the heaviest australites (say, greater than 200 g) might be at the southern ends because of a mass grading effect, and if their mode of dispersal was such that the heaviest ones arrived last, rotation of the earth could leave them distributed along the western sides of the sectors. The peculiar grouping of large australites at the southern end (**Fig. 1**) is likely to be, at least in part, an effect arising from the distribution of human population. The western group is in the wheat belt whilst the eastern is in the narrow strip of country running north and south from Kalgoorlie and associated with mining; the intervening country is uninhabited (Cleverly 1976). A round core of 95.7 g found at Lake King within the gap by an itinerant worker lends support to the supposition that the gap in australite occurrence will cease to exist when the area is inhabited. The continued recording of the distribution of not only the unusually massive australites, but of all australites is desirable.

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REFERENCES

BAKER, G. (1966)—Hollow australite button with flange, Hordern Vale, Otway Peninsula, western Victoria. *Meteoritics* 3(1): 35-53.

CHAPMAN, D.R. (1964)—On the unity and origin of the Australasian tektites. *Geochim. et cosmochim. acta* 28(6): 841-880.

CLEVERLY, W.H. (1974)—Australites of mass greater than 100 grams from Western Australia. *J. Proc. R. Soc. West. Aust.* 57(3): 68-90.

CLEVERLY, W.H. (1976)—Some aspects of australite distribution pattern in Western Australia. *Rec. West. Aust. Mus.* 4(3): 217-239.

CLEVERLY, W.H. (1979a)—Broad oval australite core from Muntadgin, Western Australia. *Rec. West. Aust. Mus.* 7(2): 245-253.

CLEVERLY, W.H. (1979b)—Morphology of small australites from the Eastern Goldfields, Western Australia. *J. Proc. R. Soc. West. Aust.* 61(4): 119-130.

CLEVERLY, W.H. & SCRYMGOUR, J.M. (1978)—Australites of mass greater than 100 grams from South Australia and adjoining states. *Rec. S. Aust. Mus.* 17(20): 321-330.

SCRYMGOUR, J.M. (1978)—Three large australites from South and Western Australia. *Rec. S. Aust. Mus.* 17(21): 331-335.

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