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SCIENTIFIC CORRESPONDENCE

A tektite fragment discovered in the Central Indian Basin

On the basis of various lines of evidence^{1,2}, tektites are now considered as glassy objects generated by meteorite impacts, distributed in four known strewn fields of which, the Australasian tektite strewn field is the youngest (0.77 Ma) and the largest encompassing 1/10 of the Earth's surface³. Tektites of this strewn field exhibit morphological differences in different geographic domains, such as the blocky, layered Muong Nongtype tektites in the Indo-China region in the north, splash form types in the centre and the aerodynamically ablated forms in Australia in the south⁴. Although microtektites, which are microscopic counterparts of tektites (< 1 mm) have been found in over 40 sites in the oceans⁵, its occurrences are known only on land but for rare exceptions^{6,7}. We report here the finding of a tektite fragment from the surface sediments of the Central Indian Basin (CIB).

After the discovery of the australite button in the ocean floor of the CIB⁷, we embarked upon a massive search of

the samples collected for the Indian Polymetallic Nodule Programme during the last decade. We searched samples from 9507 operations of free fall grabs, located between 1° and 21°S and 70° to 88°E in the CIB. This tektite was discovered in a grab sample from station 74 A of the second cruise of *MV Skandi Surveyor* (23 Sept.-6 Nov. 1982) at the location 17°00'S; 78°001'E (depth 4990 m) (Figure 1). Along with the tektite, ~250 g of small (<2 cm average size) manganese nodules have been recovered, and since the grab sampler (sampler penetration 15 cm) has a net of 6 mm mesh, the associated sediment has been filtered away during the ascent of the grab to the sea surface, effectively no sediment from this location was recovered.

A ~4 mm piece of the tektite was broken off, mounted in epoxy, polished and electron microprobe analysis was carried out with a Cameca CAMEBAX model 571 electron probe microanalyser for seven spots (Table 1) using silicate

and oxide standards. ZAF corrections were made with an online computer using the method of Bence and Albee⁸. A synthetic tektite standard (USNM 2213) made by Corning Glass Company and analysed by the USGS which was kindly provided by the Smithsonian Institution (Washington), was also analysed to check the accuracy of analysis. Scanning electron microscopy was done with a JEOL JSM-T330A electron microscope.

This tektite fragment measures 14.5 × 7.5 mm, and weighs 0.44 g. It appears to be a part of a large tektite which fragmented while it was hot, possibly upon contact with the cool sea surface. It has a 'ledge' around it having sharp edges, outlining the border from which it was fragmented from the original tektite (Figure 2a). The smooth exterior has a convex shape and represents the original tektite surface (Figure 2b). The interior of the tektite is uneven, has conchoidal fracturing and the overhanging ledge shows flow lines at the equatorial region which could be schlieren exposed

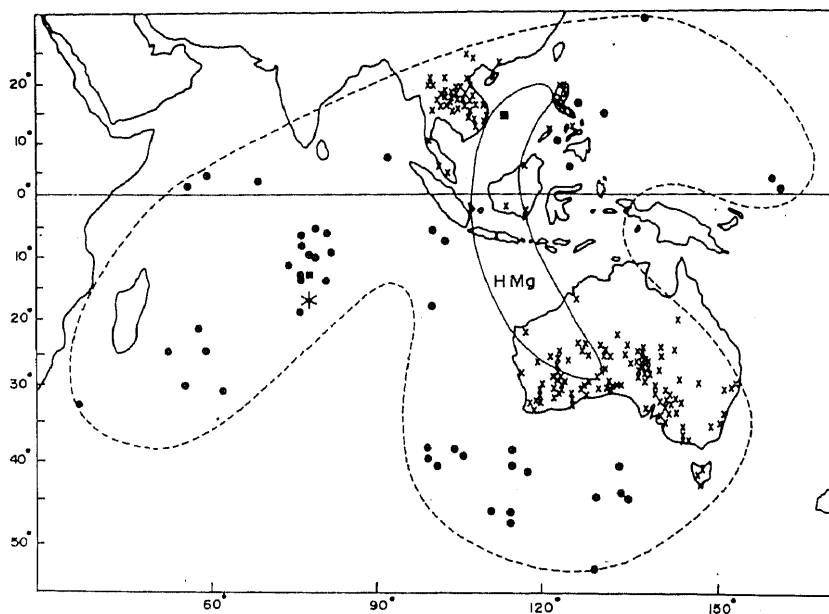


Figure 1. The Australasian tectite strewn field (ref. 2). Star denotes the location of the present tectite. The dotted lines denote the boundaries of the strewn field, squares show tectite occurrences in the ocean and filled circles, microtektite occurrences. The crosses show tectite locations on land. The crescent indicates the geographic boundaries of HMg tectites on land (ref. 13).

Table 1. Chemical composition of the tectite

	Present study ¹	CIB button ²	HMg-tektites ³
SiO ₂	67.0	68.7	64.8–77.0
Al ₂ O ₃	15.9	13.3	10.7–13.3
FeO	5.8	6.33	3.85–8.6
MgO	3.5	3.82	1.83–7.95
CaO	2.6	3.74	1.79–2.56
K ₂ O	2.5	2.00	1.34–2.56
Na ₂ O	1.1	0.92	0.62–1.38
TiO ₂	0.8	0.63	0.66–0.77
Sp. Gr.	2.508	2.508	2.381–2.591
R.I.	1.528	1.528	1.501–1.544

¹Average for seven spots; ²From Glass *et al.*²⁵; ³Range of HMg tectite composition from Chapman and Scheiber¹².

by etching (Figure 3 a, b). A pointed beak-like projection protrudes from the interior side (Figure 3 c). Seafloor etching is observed in the form of grooves and canals in the tectite interior having a width up to ~100 μm (Figure 3 d). A few pits are observed on the exterior surface, the largest of which, a bubble pit, measures 50 μm (Figure 3 e).

Studies on solution of Australasian microtektites show 0.4–28 μm etching, but most of the solution is less than 5 μm (ref. 9), because in deepsea conditions the Mg in sea water forms a protective microlayer retarding etching process¹⁰. Whereas on land, tectites show signi-

ficantly high amounts of solution etching ranging from 100 to 2500 μm (ref. 11). Therefore, the 100 μm wide grooves on the interior of the tectite, which represent 50 μm of solution etching, indicate more solution than those observed on microtektites in the same region. Glass⁹ observations on microtektites of all strewn fields revealed that etching takes place mostly when the microtektite is retained at the sediment–water interface, and the etching action ceases once the microtektite is buried in the sediment column. Since this tectite was found in the surface sediments, it has therefore been exposed to etchants for practically throughout its

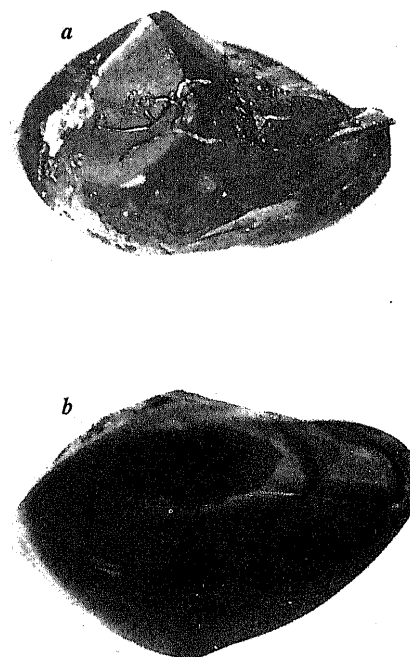


Figure 2. a, Photomicrograph of the tectite as viewed from the 'posterior' or the tectite interior. The ledge around the fragmented surface is visible at the edges where this fragment had broken off. Tectite size: 14.5 × 7.5 mm; b, The outer, mirrorsmooth surface of the tectite.

residence time, i.e. for 0.77 my, and has been exposed to etchants for much longer periods than microtektites. This could be the reason for greater amount of etching seen here. However, the CIB button has a 32 μm groove on its anterior outlining the flange⁷ which represents 16 μm of solution etching. Although the CIB button and the tectite in this study were discovered under identical conditions, the difference in solution etching between these two tectites is strange.

The high RI (1.528), sp. gr. (2.505) and the chemistry of this tectite (Table 1) correspond to the high-Mg (HMg) group of tectites¹². The RI and the sp. gr. of the CIB button and of this tectite are identical and the SiO₂ contents are similar, however, there are differences in the other major elements (Table 1). Interestingly, both the tectites found in the Indian Ocean belong to the HMg group. Tectite groups as defined by Chapman and Scheiber¹² have constant compositions reflected by their physical properties. They are distributed in ray-like patterns of which the HMg group forms a crescent arcing from West Central Australia northwest across Indonesia then northeast over the South China Sea

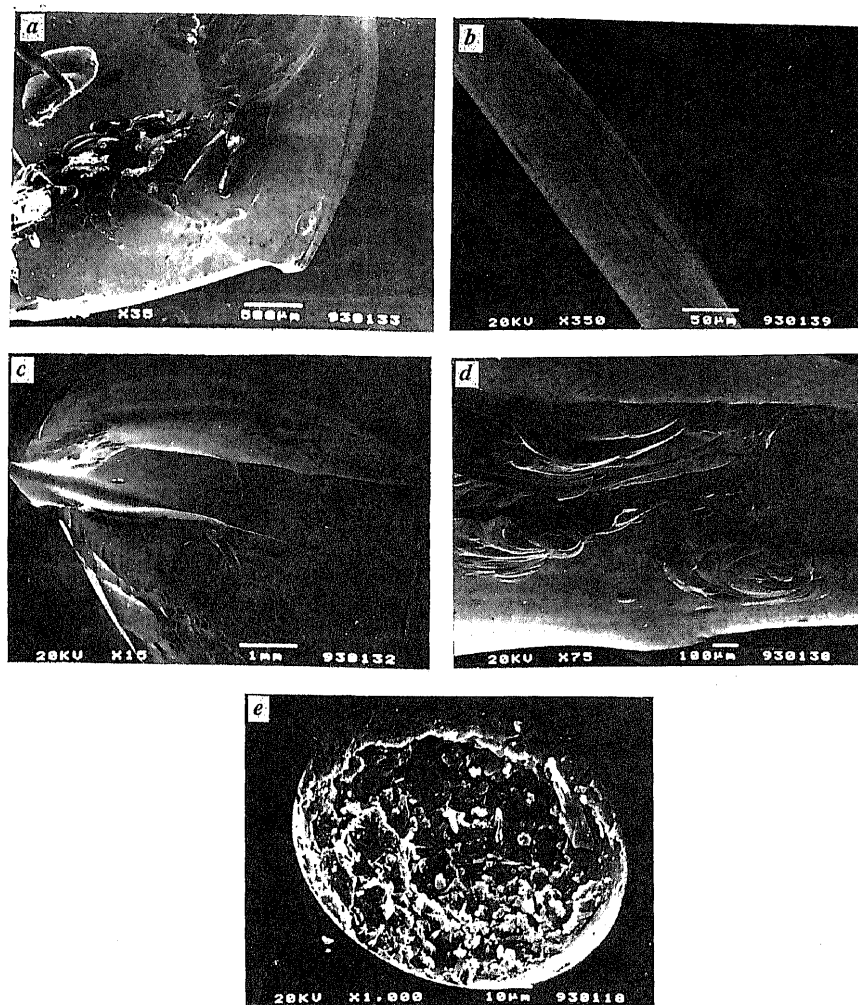


Figure 3. *a*, SEM picture from the interior showing the edge and flow lines; *b*, A magnified view of the flow lines shown above; *c*, An edge of the tektite as viewed from the interior, a pointed beak is seen here. Etching grooves can be seen at the top of the photograph; *d*, Magnified picture of grooves and canals generated by ocean floor etching on one side of the tektite; *e*, An exposed bubble cavity on the outer surface of the tektite. The material inside appears to be deep-sea clay.

(Figure 1), and are characterised by sp. gr. >2.47; Mg >3.4%; Ni >210 ppm and Cr >210 ppm (ref. 13). Mason¹⁴ also observed the HMg group of tektites to be confined within well defined geographic limits in Australia.

The present finding in the CIB could mean either it has been transported from the Australian region or from further north where splash form tektites of HMg compositions have been found or it belongs to the site where it was recovered from. Bottom water transport from these land masses to the CIB can be ruled out, because the tektite is well preserved (the outer surface is mirrorsmooth, and the equatorial region has sharp edges) and does not bear any abrasion marks indicative of long distance transport of over

4000 km from these regions to the present site. Further, the bottom water currents near west Australia, Sumatra and Java do not travel diagonally across into the CIB, but they proceed northwards into the Wharton Basin and enter the Indian Ocean from the saddles in the Ninety East Ridge at 10°S (ref. 15), which is a few thousand km from the location of this tektite, therefore eliminating the possibility of transport of this centimeter-sized tektite.

Bottlegreen (HMg) microtektites have been reported from the Indian Ocean which have similar chemical compositions to those of the HMg group of tektites¹⁶. However, in an ejecta plume the atmosphere winnows out the finer fraction of debris from the ejecta, which may remain

suspended for long periods of time, thereby posing a problem for ordinary atmospheric dispersal mechanisms for the microtektites¹⁷. The HMg tektites on the other hand, have a definite raylike distribution on land. The discovery of the flanged button in the CIB (a HMg tektite) was suggested to signify the existence of another ray of tektite distribution⁷. Chapman¹³ suggested that streaks of constant composition are ejected in rays subsequent to an impact, the present finding therefore confirms a HMg component to the ray of Australasian tektites in the Indian Ocean.

Further, this tektite has also been found in the surface sediments and given the 0.77 Ma age of the Australasian tektite strewn field¹⁸ and the sedimentation rates of 2–3 mts/my in this location¹⁹, it should have been buried under a load of ~2 m of sediments. However, the associated manganese nodules are small, spherical and have uniform surface textures which indicate strong local bottom water currents²⁰, which could have removed sediments younger than 0.77 Ma. Alternatively, the ocean floor of the CIB is strewn with millions of tons of manganese nodules having similar physical properties: generally spherical shapes, a wet density of ~2.40 and nodules in the size range 1–2 cm are not rare; they are retained at the ocean floor for several million years by a mechanism which is still not perfectly understood, although many plausible explanations have been proposed^{21,22}. It, therefore, appears that a similar mechanism(s) has been responsible for the near-surface retention of this tektite. Including the tektite in this study, so far only two tektites have been found in the Indian Ocean and both of them have not been buried under a load of sediments younger than 0.77 Ma as is expected but were resting on the ocean floor. Whereas, in the >40 Australasian microtektite sites in the oceans, the microtektite layer has been found buried at 0.7–11 m (ref. 23) beneath the deep sea floor. At one site, however, the microtektite layer has been found at core depths 13–16 cm. However this location was on the flank of a seamount and the near surface occurrence of the microtektite peak abundance was suggested to be either due to sediment slumping or removal of younger sediment to enhanced bottom current activity in the location²⁴. The possibility thus emerges that in the oceans,

there are two layers of Australasian impact ejecta at two different stratigraphic levels although they belong to the same impact event: the larger tektites are retained at the surface due to the mechanisms similar to those responsible for the ocean floor retention of manganese nodules, and the smaller microtektites sink to the appropriate stratigraphic levels beneath the sea floor corresponding to the 0.77 Ma age of the event. This, however, needs to be confirmed by the finding of microtektites at deeper levels in the sediment column in a sediment core from this location.

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Breeding and improved hatchery technology for the giant freshwater prawn, *Macrobrachium rosenbergii* in Karnataka

The giant freshwater prawn, *Macrobrachium rosenbergii* is popularly known as scampy. The species has been widely cultured in Asian countries such as Thailand, Taiwan, Malaysia, Indonesia, Bangladesh and India. It is also farmed in USA, particularly in South Carolina and Hawaii provinces. The first breakthrough was achieved by S. W. Ling¹ in successful breeding and larval rearing of the giant prawn, *M. rosenbergii* in controlled condition. Later mass production of larvae using greenwater system was

developed by Fugimura and coworkers in Hawaii². The prawn spends its entire life in freshwater rivers and tanks but migrates to brackishwater estuaries for breeding because the larvae do not survive in freshwater. The berried female prawn reaches estuaries before the eggs hatch out. This mystery was known only after the pioneering work of Ling.

The giant freshwater prawn is popularly cultured because of the beneficial factors like its fast growth compared to other freshwater prawn species, its hardy nature

in withstanding adverse environmental conditions, its low protein requirement compared to penaeid shrimps, resistance to diseases, its consumer preference and demand in the export market. Further, it is a compatible species for polyculture with carps. Although it is commercially cultured in several Asian countries, its culture in India is unorganized. The seed required for culture is largely met from wild collection, although few hatcheries exist in the states of Andhra Pradesh, Kerala and Tamil Nadu.