

Morphological and chemical properties of Microtektite grains from Bay of Bengal (IODP Expedition: 354)

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November 24, 2022

Abstract

This study reports the presence of Australasian microtektites in a deep-sea core (U1452) retrieved during International Ocean Discovery Program (IODP) Expedition 354: Bengal Fan. These microtektites are found within a foraminifera-rich calcareous clay layer beneath the Brunhes–Matuyama (B–M) magnetostratigraphic boundary. Most of them are spherical and are less than one millimeter in diameter. Typical splash (dumbbell, teardrop, button etc.) and irregular-shaped forms were recovered. The most abundant microtektites are pale green in color, followed by opaque, pale brown, translucent and transparent varieties. They are characterized by various surficial attributes including pits, mounds, grooves and fractures. Geochemical analyses suggest that the major oxide compositions are very similar to Australasian microtektites, Australasites reported elsewhere and also to the average composition of upper crustal rocks. Transparent bottle green microtektites are relatively richer in MgO content and lower in silica to other microtektites found in U1452. Minor and trace elements show a wide range of distribution and individual samples show variation. Differences in minor and trace elements concentration are possibly due to the contamination from the impact ejecta. Other than microtektites, presence of possibly polymetallic exsolution texture, shocked minerals and unmelted and partly melted ejecta within the microtektite-bearing layer in the northern Indian Ocean provides further evidence that the Australasites and Australasian microtektites might have been formed by the impact of an extraterrestrial projectile at ~0.8 Ma, somewhere in Indochina.



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Introduction

Australasian microtektites in a deep-sea core (U1452B) are retrieved during the International Ocean Discovery Program (IODP) Expedition 354 within a foraminifer-rich calcareous clay layer beneath the Matuyama-Brunhes (M-B) magnetostratigraphic boundary. The main objective of the study is to report the morphological and chemical variation of the microtektites, compare them with known occurrences from the Australian strewn field, and assess whether they are derived from a similar source.

Study Region

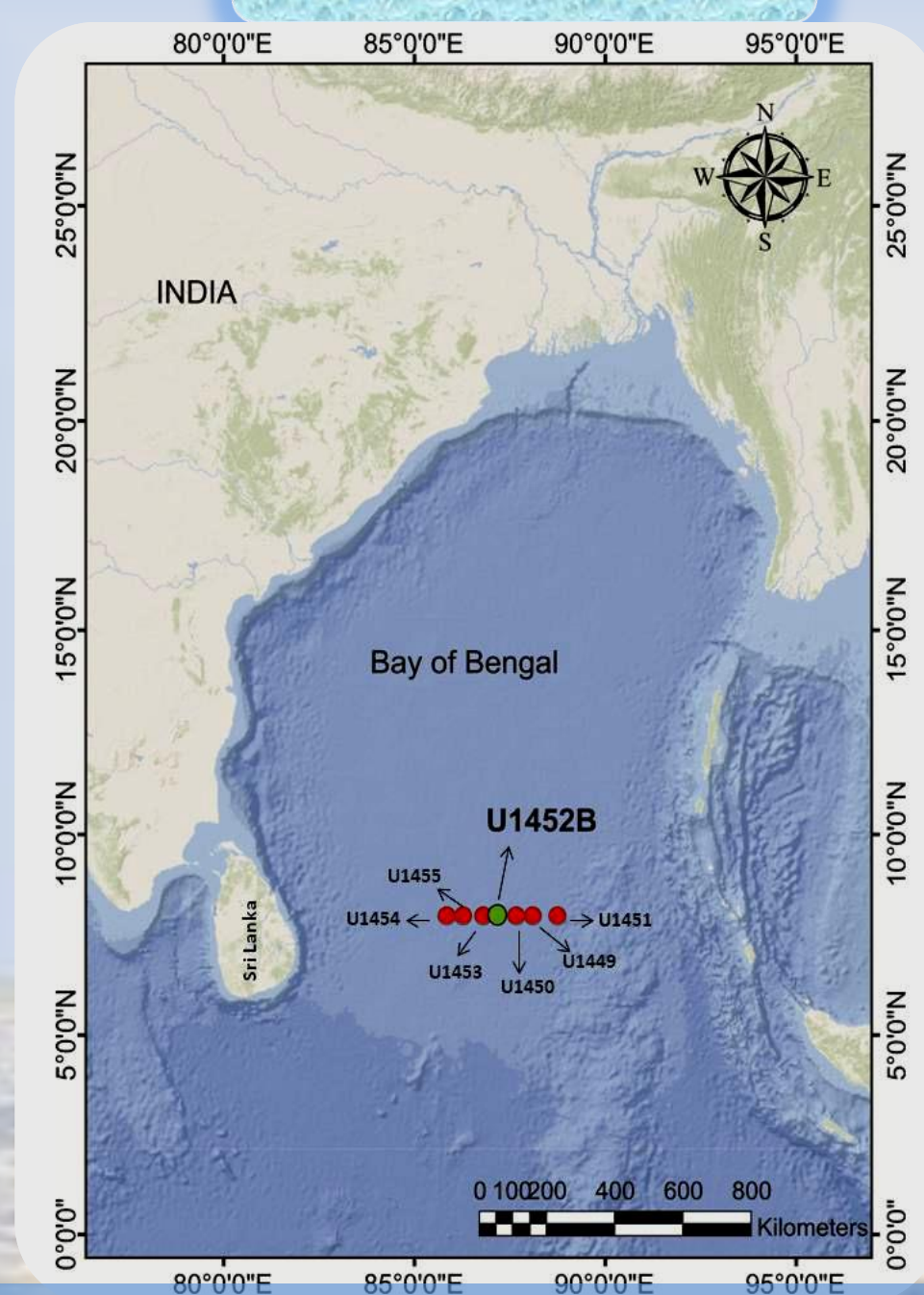


Fig.1. Location map of Expedition 354.

- Site U1452 is located in a relatively flat environment with a smooth morphology.
- IODP Site U1452 Hole B - (8°0.4191'N and 87°10.9128'E)
- Water Depth - 3670.3 m

Materials and Methods

- Microtektites was identified in 5 cm thick foraminifer-rich calcareous clay layer (36F-CC, 184.52–179.52m CSF-A) underneath Toba ash layer.
- The coarse fraction (>63 µm) separated by sieving
 - Microtektite
 - Opaque
 - Glass grains

- The specimens were examined under the FE-SEM JEOL 7610F and representative grains were examined for elemental distribution using (EDS) EDAX Peltier cooled octane plus 30mm² detector attached to the SEM.

Result and Discussion

❖ Morphological Characteristic

❖ Chemical Characteristics

Fig.2. Biostratigraphic chronostratigraphic markers U1452.

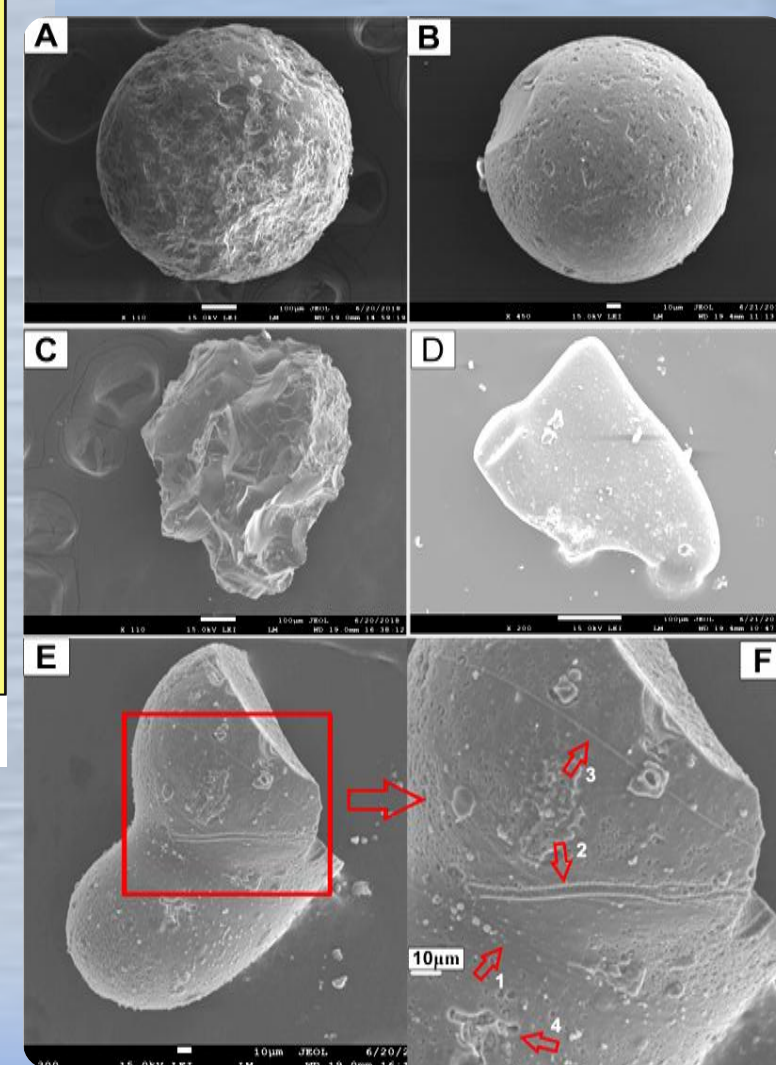


Fig.3. Morphology and sculpturing on microtektite

Morphological Characteristics

Shape: spherical, teardrops, dumbbells, button and discs, irregular, broken spherical.

Size : All <1mm in diameter.

Largest is a spherical one - ~700 µm diameter

Color: Transparent to translucent. Varies from colorless to pale-yellow to greenish yellow, to dark brown and opaque.

Surface Sculpture: pits, mounds, grooves and conchoidal fractures.

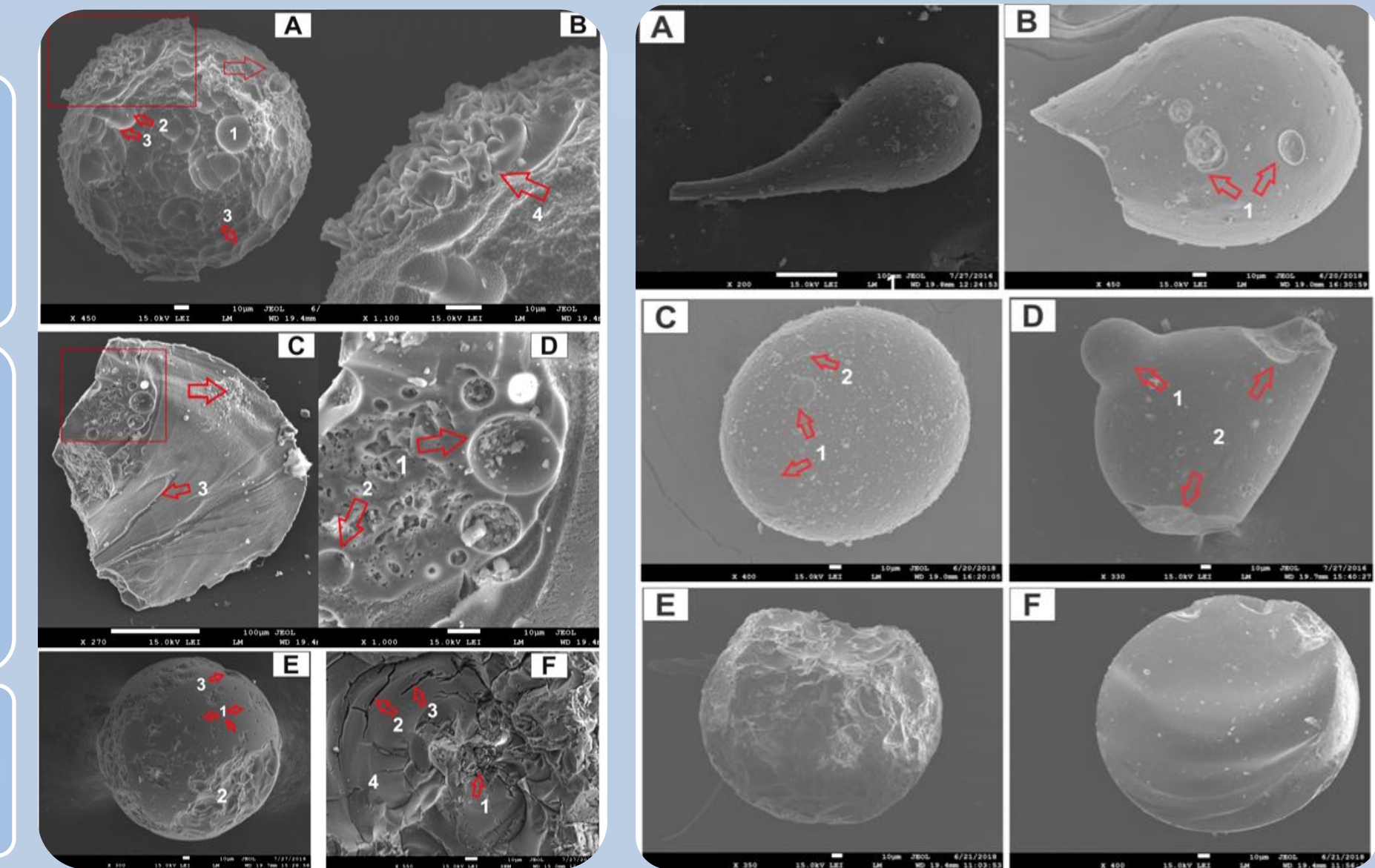


Fig.4. Morphology and sculpturing on microtektite

Chemical Characteristics

❖ Normal and bottle green microtektites are distinguished in major oxide content.

❖ Transparent bottle green are characterized by low silica and high MgO(>16%).

❖ Australasian microtektites are depleted in SiO₂, TiO₂ & Fe₂O₃ than both the Ivory Coast and North American microtektites, but richer in MgO, CaO & K₂O.

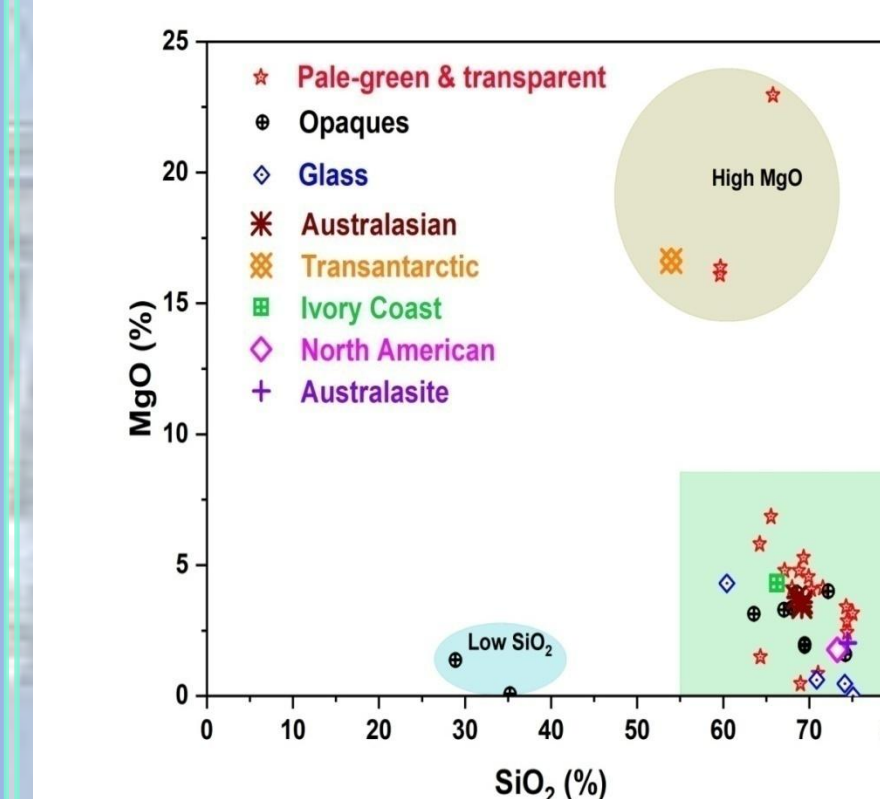


Fig.5. MgO vs. SiO₂ diagram for microtektites from different strewn fields

Major Oxides	Present study				
	Normal				Bottle Green
	Translucent Brown	Opaque	Transparent	Plae Green	Bottle green
	Avg wt%	Avg wt%	Avg wt%	Avg wt%	Avg wt%
SiO ₂	67.20	69.52	70.32	70.25	59.65
TiO ₂	0.55	0.49	0.42	0.41	0.58
Al ₂ O ₃	12.79	13.01	10.22	12.50	12.01
FeO /Fe ₂ O ₃	3.23	3.10	2.79	4.22	2.94
MgO	3.05	3.27	4.24	3.92	16.24
CaO	2.44	3.00	3.89	3.50	2.63
Na ₂ O	0.73	1.21	1.80	0.58	0.91
K ₂ O	2.89	2.79	2.37	1.72	1.12

Fig.6. Major oxide % of Australasian microtektites

✓ Translucent brown, opaque & bottle greens are richer than the transparent and pale green microtektites in minor and trace elements.

Conclusion

Microtektites, from lower Bengal Fan, occur beneath the M-B polarity reversal at around ~0.8 Ma.

✓ Characterized by distinct morphologic character and surface sculptures.

✓ Major oxides and the trace elemental concentration point out that they have originated from the same sources and processes as that of Australasian tektites and microtektites.

✓ Polymetallic exsolution texture (Widmanstatten Pattern) observed, suggests impact of an Octahedrite or Iron Meteorite some where in Indochina at ~0.8 Ma .

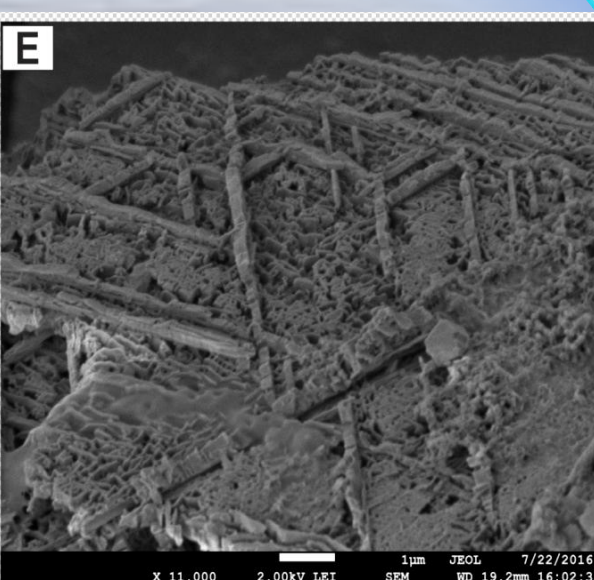


Fig.7. Widmanstatten texture on surface of a substance found within microtektite layer