

Micropaleontological proxies as tool to date serpentinite mud volcanism and seamount subduction and to reconstruct paleoenvironmental conditions in the Mariana convergent margin system (IODP Expedition 366)



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GEOLOGICAL SETTING

IODP Expedition 366 recovered cores from three serpentinite mud volcanoes at increasing distances from the Mariana trench subduction zone along a south-to-north transect: Yinazao (Blue Moon), Fantangisña (Celestial), and Asùt Tesoru (Big Blue) (Figure 1). These cores consist of serpentinite mud containing lithic clasts derived from the underlying forearc crust and mantle, as well as from the subducting Pacific Plate. Additionally, in situ pelagic sediments and volcanic ash deposits underlying the serpentinite mud volcanoes were recovered at Fantangisña. A thin cover of pelagic sediment was found at many sites.

The main component in all cores was serpentinite mud (Zone 1 in Figure 2). In contrast to lithic serpentinite, which is typically light green in color, the serpentinite mud ranged from pale green to dark blue-gray in color, except in the upper few meters, which are typically oxidized to yellow-orange color. Ultramafic clasts are the dominant clast type at all of the seamounts (Zone 4). These are mainly harzburgite (<<5% clinopyroxene) with less common dunite and pyroxenite. The clasts display serpentinitization degrees from 30 to 100%.

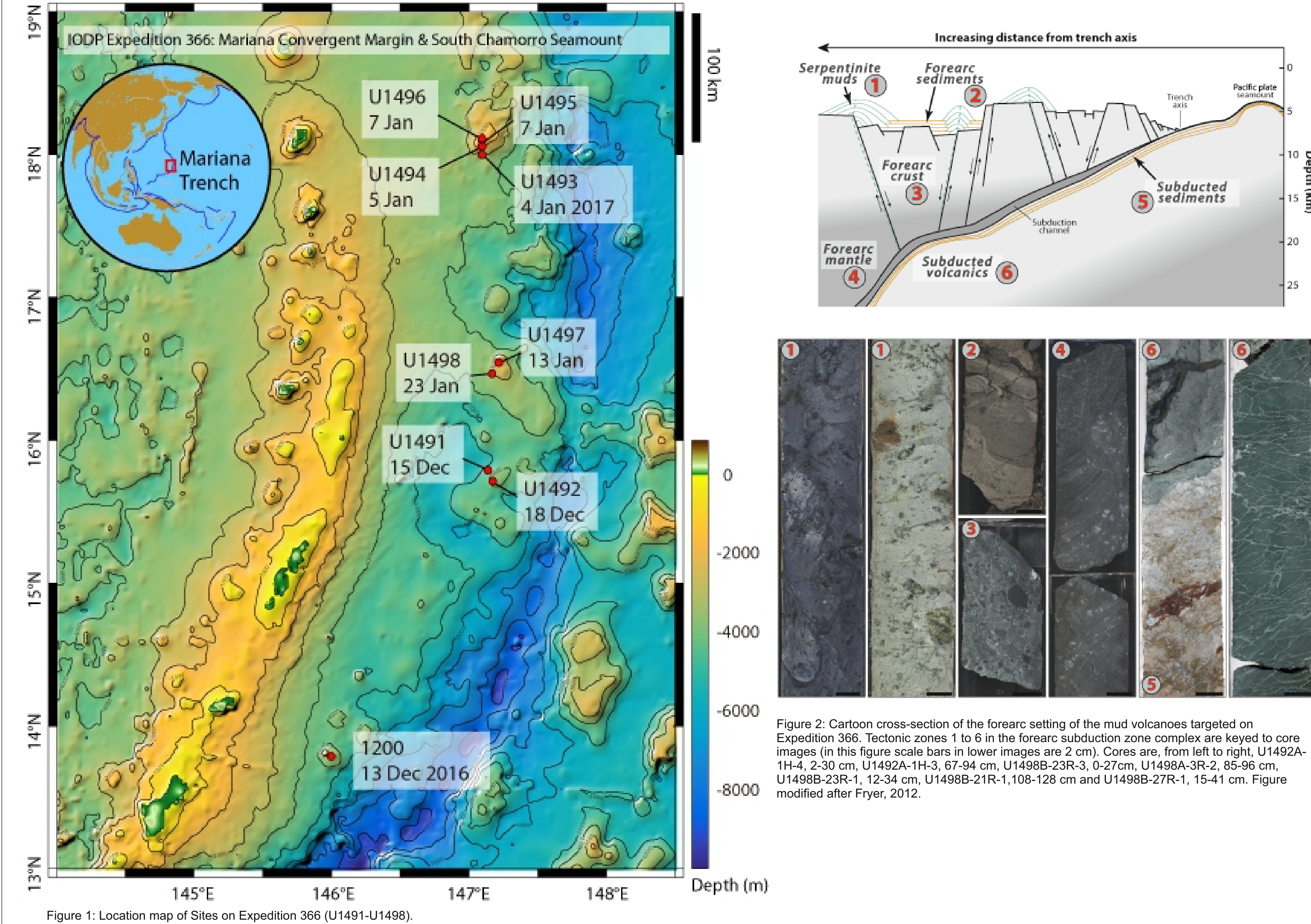


Figure 1: Location map of Sites on Expedition 366 (U1491-U1498).

Crustal rocks derived from both the underlying forearc crust (Zone 3) and from the subducting Pacific plate (Zones 5 and 6) are found at several sites, but they form a major fraction of the recovered clasts at three sites: U1496 (Asùt Tesoru summit), U1497 and U1498 (Fantangisña summit and flank). Volcanic clasts from Fantangisña include forearc basalts (Zone 3), boninite and volcanic glass (boninitic), as well as greenstones and subgreenschist (prehnite-pumpellyite facies) metavolcanics (Zone 6). Meta-sediments from sites U1497 and U1498 are characterized by recrystallization of calcareous and siliceous microfossils (Zone 5).

The seamounts are overlain by pelagic sediment, sampled at site U1498, which is composed of volcanic ash, calcareous nannofossils (discoasters and coccoliths), foraminifera, radiolarian and sponge spicules (Zone 2). A similar pelagic sediment overlies most sites as well. The underlying volcanic ash with nannofossils allow to establish a maximum age for mud volcano activity, whereas the overlying pelagic mud that blankets the surface of the volcanoes (Figure 3) constrains their most recent activity.

PLANKTIC FORAMINIFERA BIOSTRATIGRAPHY (PRELIMINARY RESULTS)

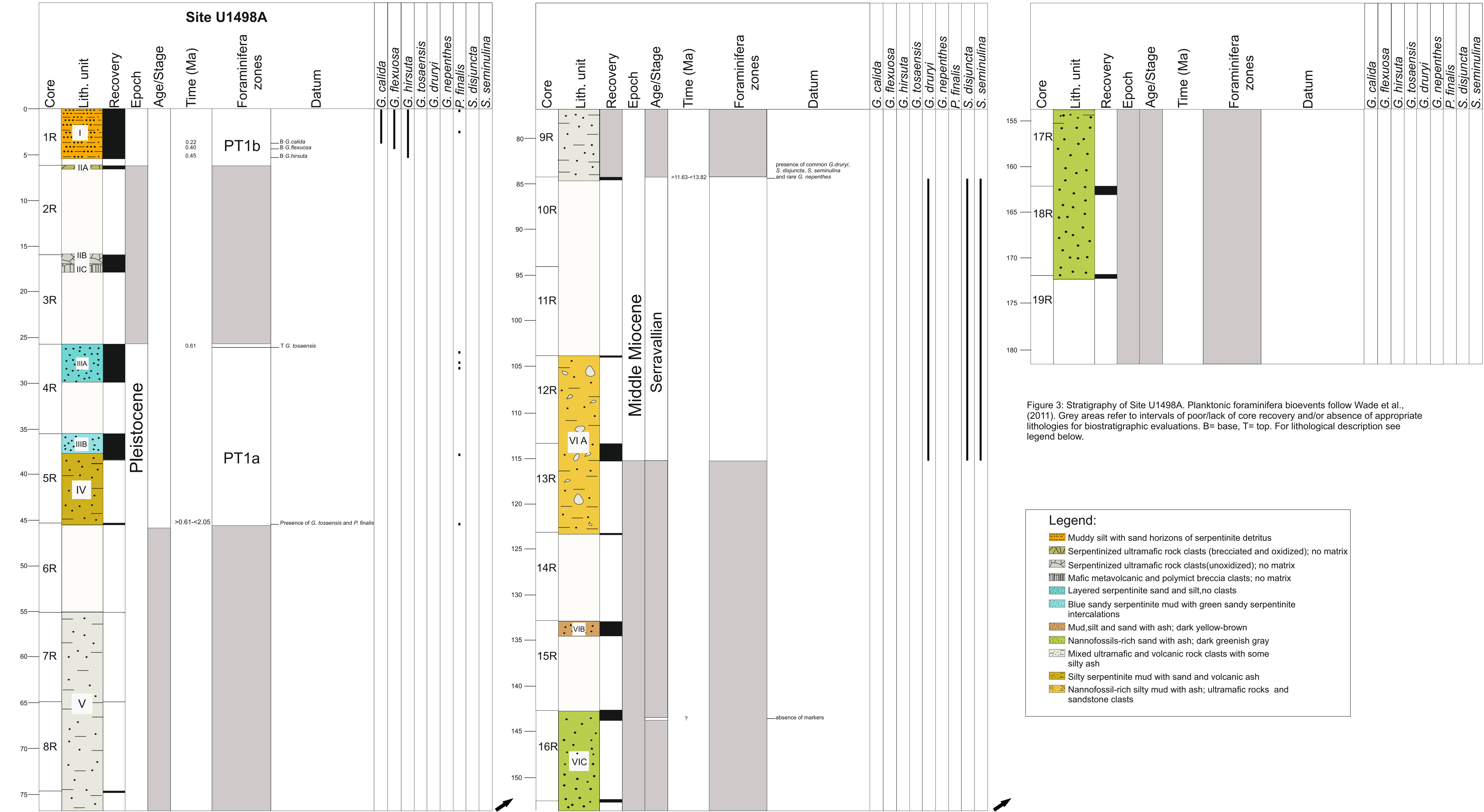


Figure 3: Stratigraphy of Site U1498A. Planktonic foraminifera bioevents follow Wade et al., (2011). Grey areas refer to intervals of poor/lack of core recovery and/or absence of appropriate lithologies for biostratigraphic evaluations. B= base, T= top. For lithological description see legend below.

A total of 43 samples was analyzed from Site U1498A (Figure 3). Planktonic foraminifera preservation ranges from poor to very good. Depth values are expressed in Core depth below see floor-A, CSF-A (mbsf). Several biostratigraphic events were recognized for the Pleistocene. *Globigerinella calida* occurs from the topmost sample 1R-1W, 6-8 (0.06 mbsf) to sample 1R-4W, 1-3 (3.78 mbsf). The base of the taxon corresponds to an absolute age of 0.22 Ma. The above-mentioned samples also contain *Globorotalia flexuosa* (Top 0.07 Ma) and *Globorotalia hirsuta*, thus dated younger than 0.22 Ma but older than 0.07Ma. The absence of *Globigerinella calida* and the occurrence of *Globorotalia flexuosa* in samples 1R-4W, 61-63 (4.36 mbsf) and 1R-4W, 120-122 (4.97 mbsf) allow to infer an age between 0.22 Ma and 0.44 Ma (Base *G. flexuosa*). The base of *G. hirsuta* (0.45 Ma) was observed in sample 1R-4W, 148-150 cm (5.25 mbsf). The top of *Globorotalia tosaensis* was recorded in sample 4R-1W, 45-47 cm (26.25 mbsf) determining the base of the subzone PT1b. It occurs continuously in the stratigraphic range until 45.50 mbsf (sample 6R-CC W 8-10). Furthermore, the contemporaneous presence of *Globorotalia tosaensis* and *Pulleniatina finalis* (Base 2.05 Ma) in sample 6R-CC W 8-10 establish an age older than 0.61 Ma and younger than 2.05 Ma.

The Pleistocene/Pliocene boundary, the entire Pliocene and late Miocene are not indicated in Site U1498A due to poor core recovery.

The common occurrence of *Sphaeroidinellopsis disjuncta*, *Sphaeroidinellopsis seminulina*, *Globoturborotalita druryi* and rare *Globoturborotalita nepenthes* suggests a middle Miocene age (Serravallian) from sample 10R-CC W 11-15 (84.41 mbsf) to sample 13R-CC W 15-17 (115.30 mbsf).

Sample 16R-CC W 4-6 (143.59 mbsf) contains very few foraminifera and no stratigraphic markers were recorded.

A detailed analysis of Calcareous nannofossils will possibly refine the biostratigraphy for Site U1498A.

DISTRIBUTION OF PLANKTIC FORAMINIFERA (PRELIMINARY RESULTS)

Exp.	Site/Hole	Core/Section	Depth	Top depth CSF-A (m)	Bottom depth CSF-A (m)	Foram age (Ma)	Foram Zone	Preservation	Total	Foram. Species	Foram. Abundance
366	U1498A	1R-1W	6-8	0.06	0.08	<0.22>0.07	PT1b	G/M	497	<i>Globigerinella calida</i>	R
366	U1498A	1R-1W	28-30	0.28	0.30	<0.22>0.07	PT1b	G/M	532	<i>Globigerinella calida</i>	R
366	U1498A	1R-1W	58-60	0.58	0.60	<0.22>0.07	PT1b	G	360	<i>Globigerinella calida</i>	R
366	U1498A	1R-1W	134-136	1.34	1.36	<0.22>0.07	PT1b	G	397	<i>Globigerinella calida</i>	R
366	U1498A	1R-2W	2-4	1.52	1.54	<0.22>0.07	PT1b	G	384	<i>Globigerinella calida</i>	R
366	U1498A	1R-2W	59-61	2.09	2.11	<0.22>0.07	PT1b	G	451	<i>Globigerinella calida</i>	R
366	U1498A	1R-2W	89-91	2.39	2.41	<0.22>0.07	PT1b	G	331	<i>Globigerinella calida</i>	R
366	U1498A	1R-3W	0-3	2.50	2.53	<0.22>0.07	PT1b	G	349	<i>Globigerinella calida</i>	R
366	U1498A	1R-3W	29-31	2.79	2.81	<0.22>0.07	PT1b	G	368	<i>Globigerinella calida</i>	R
366	U1498A	1R-3W	61-63	3.11	3.13	<0.22>0.07	PT1b	G	341	<i>Globigerinella calida</i>	R
366	U1498A	1R-4W	1-3	3.76	3.78	<0.22>0.07	PT1b	G/M	355	<i>Globigerinella calida</i>	R
366	U1498A	1R-4W	61-63	4.36	4.38	<0.40>0.22	PT1b	G/M	353	<i>Globigerinella calida</i>	R
366	U1498A	1R-4W	120-122	4.95	4.97	<0.40>0.22	PT1b	G	376	<i>Globigerinella calida</i>	R
366	U1498A	1R-4W	148-150	5.23	5.25	>0.40<0.45	PT1b	G	392	<i>Globigerinella calida</i>	R
366	U1498A	6R-CC W	1-3	45.41	45.43	>0.61<2.05	PT1a	M	22	<i>Globigerinella calida</i>	R
366	U1498A	6R-CC W	8-10	45.48	45.50	>0.61<2.05	PT1a	G/M	379	<i>Globigerinella calida</i>	R
366	U1498A	13R-2W	15-17	113.98	114.00	>11.63<13.82	Serravallian	G	161	<i>Globigerinella calida</i>	R

Figure 4: Relative abundances of planktonic foraminifera at site U1498A. At least 300 specimens from the 500-125 µm size fractions were identified from random counts and indicated as follows: A= abundant (>20%-50% of the washed sample); C= common (>5%-20% of the washed sample); F= few (<1%-5% of the washed sample); R= rare (<1% of the washed sample). Sample preservation categorized as follows: G= good (mostly whole specimens, well preserved ornamentation, nearly all specimens identifiable at the species level); M= moderate (specimens often etched or broken, most specimens identifiable at the species level).

Reference:

- Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists, 2018. Mariana Convergent Margin and South Chamorro Seamount, In: Proceedings of the International Ocean Discovery Program 366 (2018).
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- Wade et al., 2011. Review and revision of Cenozoic tropical planktonic foraminiferal biostratigraphy and calibration to the geomagnetic polarity and astronomical time scale. Earth-Science Reviews 104, 111-142.