

Supplementary Table S1. Benthic foraminiferal species of MES.

Species	MES 1	ME S 5	ME S 8	ME S 15	ME S 16	MES 17	ME S 22	ME S 24	MES 25	ME S 27	ME S 29
<i>Bigenerina</i> sp.	0	0	0	0	1	0	1	1	0	0	0
<i>Bigenerina agglutinans</i> d'Orbigny, 1846	0	1	0	0	0	0	0	1	0	0	0
<i>Bigenerina</i> cf. <i>agglutinans</i> ?	1	0	1	0	0	0	0	1	0	0	0
<i>Bigenerina nodosaria</i> d'Orbigny, 1826	0	0	0	1	1	0	1	1	1	1	0
<i>Cibicides lobatulus</i> (Cushman, 1910)	0	0	0	0	0	0	0	1	0	0	0
<i>Cyclammina subtrullissata</i> (Parr, 1950)	0	0	0	0	0	0	0	1	0	0	0
<i>Cyclammina trullissata</i> (Brady, 1879)	0	0	0	0	0	0	0	1	0	0	0
<i>Cylindroclavulina</i> sp.	0	0	0	0	0	0	0	1	0	0	0
<i>Reophax</i> cf. <i>agglutinans</i> Cushman, 1913	0	1	0	0	0	0	0	0	0	0	0
<i>Reophax communis</i> Lacroix, 1930	1	1	1	0	0	0	0	0	0	0	0
<i>Reophax scorpiurus</i> Montfort, 1808	0	0	0	0	0	0	1	1	0	0	0
<i>Rhizammina algaeformis</i> Brady, 1879	0	0	0	0	0	0	0	1	0	0	0
<i>Spiroplectinella</i> sp. (Goeting et al., 2021)	0	0	0	0	0	0	0	1	0	0	0
<i>Textularia</i> cf. <i>agglutinans</i> d'Orbigny, 1839	1	1	1	0	0	0	1	0	0	0	0
<i>Textularia accidentalis</i> Cushman, 1922	0	0	0	0	0	0	0	1	0	0	0
<i>Textularia goessi</i> Cushman, 1911	0	0	0	0	0	0	0	0	0	0	1
<i>Textularia lateralis</i> Lalicker, 1935	0	1	0	0	0	0	0	0	0	0	0
<i>Textularia porrecta</i> Brady, 1884	0	0	0	0	0	0	0	1	0	0	0
<i>Textularia pseudogramen</i> Chapman & Parr, 1937	0	0	0	0	0	0	1	0	0	0	0
<i>Textularia stricta</i> Cushman, 1911	0	0	0	0	0	0	0	1	0	0	0
<i>Tritaxilina caperata</i> (Brady, 1881)	0	0	0	0	0	0	0	1	0	0	1
<i>Adelosina laevigata</i> d'Orbigny, 1826	0	1	0	0	0	0	0	0	0	1	0
<i>Adelosina</i> sp. 4 (Goeting et al., 2021)	0	0	1	0	0	0	0	0	0	0	0
<i>Alveolinella quoyi</i> (d'Orbigny, 1826)	0	1	0	0	0	0	0	0	0	1	0
<i>Ammomassilina alveoliniformis</i> (Millett, 1898)	1	1	0	0	0	0	0	0	0	0	0
<i>Cycloforina granulocostata</i> (Germeraad, 1946)	1	1	0	0	0	0	0	0	0	0	0
<i>Dendritina Zhengae</i> Ujiié in Hatta & Ujiié, 1992	1	1	1	0	0	0	0	0	1	0	0
<i>Flintina</i> (<i>Triloculina</i>) <i>bradyana</i> Cushman, 1921	0	0	1	0	0	0	0	0	0	0	0
<i>Lachlanella</i> sp.	0	0	0	0	0	0	0	0	1	0	0
<i>Massilina</i> ? sp. (Goeting et al., 2021)	1	1	1	0	0	0	0	0	0	0	0
Miliolid genus 1 (Goeting et al., 2021)	0	1	1	1	1	0	0	0	0	0	0
<i>Parasorites orbitolitoides</i> (Hofker, 1930)	0	1	0	0	0	0	0	0	0	0	0
<i>Peneroplis planatus</i> (Fichtel & Moll, 1798)	1	1	0	0	0	0	0	0	0	0	0
<i>Planispirinella exigua</i> (Brady, 1879) or sp. (Debenay, 2012)	0	1	0	0	0	0	0	0	0	0	0
<i>Pseudohauerina orientalis</i> (Cushman, 1946)	1	1	0	0	0	0	0	0	0	0	0
<i>Pseudomassilina</i> sp. 3 (Goeting et al., 2021)	0	0	1	0	0	0	0	0	0	0	0
<i>Pyrgo sarsi</i> (Schlumberger, 1891)	0	0	1	1	0	1	0	1	1	1	0
<i>Pyrgo vespertilio</i> (Schlumberger, 1891)	0	0	0	0	0	0	0	1	0	0	0
<i>Quinqueloculina cuvieriana</i> d'Orbigny 1839	1	1	1	0	0	0	0	1	0	1	0
<i>Quinqueloculina</i> cf. <i>bicarinata</i> d'Orbigny, 1826	0	0	0	0	0	0	0	0	1	0	0
<i>Quinqueloculina</i> cf. <i>patagonica</i> d'Orbigny, 1839	0	0	0	0	0	0	0	1	0	0	0
<i>Quinqueloculina granulocostata</i> Germeraad, 1946	0	0	0	0	0	0	1	1	1	1	
<i>Quinqueloculina parkeri</i> (Brady, 1881)	1	1	1	0	0	0	0	0	0	0	0
<i>Quinqueloculina</i> sp. 2	0	1	1	0	0	1	0	1	0	0	0
<i>Quinqueloculina</i> sp. 1 (Goeting et al., 2021)	0	0	0	1	1	1	0	1	1	1	0

<i>Quinqueloculina</i> sp. 3 (Goeting et al., 2021)	0	1	1	0	0	1	0	0	1	0	0
<i>Quinqueloculina</i> sp. 6 (Goeting et al., 2021)	0	1	1	0	0	0	0	1	0	0	0
<i>Quiqueloculina philippinensis</i> Cushman, 1921	1	1	1	0	0	0	0	1	1	1	0
<i>Quinqueloculina auberiana</i> d'Orbigny, 1839	0	0	1	0	1	1	0	1	1	1	0
<i>Siphonaperta hallocki</i> Förderer & Langer 2016	0	0	1	0	0	0	0	0	0	0	0
<i>Siphonaperta subagglutinata</i> (Asano, 1936)	0	1	1	0	0	0	1	1	1	1	0
<i>Spiroloculina</i> cf. <i>scrobiculata</i> Cushman, 1921	1	0	0	0	0	0	0	0	0	0	0
<i>Spiroloculina communis</i> Cushman & Todd, 1944	1	0	1	0	0	0	0	1	1	0	0
<i>Spiroloculina concava</i> Petri, 1954	0	0	1	0	0	0	0	0	0	0	0
<i>Spiroloculina</i> sp. 1	0	1	0	0	0	0	0	0	0	0	0
<i>Spiroloculina subimpressa</i> Parr, 1950	0	1	0	1	0	0	1	1	1	1	0
<i>Triloculina tricarinata</i> d'Orbigny, 1826	0	1	0	1	0	0	0	1	0	0	0
<i>Triloculina vespertilio</i> Zheng, 1988	0	0	0	0	0	0	0	1	0	0	0
<i>Amphicoryna sublineata</i> (Brady, 1884)	0	0	0	0	0	0	0	1	0	1	0
<i>Dentalina</i> sp. 1	0	0	0	0	0	1	0	1	0	1	0
<i>Dentalina</i> sp. 2	0	0	0	0	0	1	0	1	0	1	0
<i>Dentalina catenulata</i> (Brady, 1884)	0	0	0	1	1	0	0	0	0	0	0
<i>Dentalina vertebralis</i> (Batsch, 1791)	0	1	0	0	0	1	1	1	1	1	0
<i>Laevidentalina californica</i> (Cushman & Gray, 1946)	0	0	0	0	0	0	0	1	0	0	0
<i>Lagena spicata</i> Cushman & McCulloch, 1950	0	0	0	0	0	0	1	0	0	0	0
<i>Lagena</i> sp.	0	0	0	0	0	0	0	0	0	1	0
<i>Lenticulina bradyi</i> (Cushman, 1921)	0	0	0	1	0	1	1	1	1	1	0
<i>Lenticulina echinata</i> (d'Orbigny, 1846)	0	0	0	0	0	0	1	1	1	1	1
<i>Lenticulina limbosa</i> (Reuss, 1863)	0	0	1	0	1	0	0	1	0	1	1
<i>Lenticulina vortex</i> (Fichtel & Moll, 1798)	0	0	0	0	0	0	0	1	1	1	0
<i>Marginulinopsis philippinensis</i> (Cushman, 1921)	0	0	0	0	0	0	1	1	0	1	0
<i>Nodosaria pyrula</i> (Pfleger and Parker, 1951)	0	0	0	0	0	0	1	1	0	0	0
<i>Oolina</i> sp. 1	0	0	0	0	0	0	0	0	1	0	0
<i>Planularia gemmata</i> (Brady, 1881)	0	0	0	0	0	0	1	1	1	1	0
<i>Lagena annulatacollare?</i> (Loeblich and Tappan, 1994)	0	0	0	0	0	0	0	1	0	1	0
<i>Pyramidulina catesbyi</i> (d'Orbigny, 1839)	0	0	0	0	0	1	0	0	0	0	0
<i>Pyramidulina obliquatus</i> (Parker, 2009)	0	0	0	0	0	0	0	1	0	0	0
<i>Pyramidulina</i> sp. 1	0	0	0	0	0	0	0	1	1	1	0
<i>Saracenaria angularis</i> Natland, 1938	0	0	0	0	0	0	1	1	0	1	0
<i>Spincterules compressus</i> (Loeblich and Tappan, 1994)	0	0	0	0	0	0	0	1	0	1	0
<i>Amphistegina papillosa</i> Said, 1949	1	1	0	0	0	0	0	0	0	0	0
<i>Asterorotalia pulchella</i> (d'Orbigny, 1839)	1	0	1	0	0	0	0	1	1	0	0
<i>Calcarina defrancei</i> d'Orbigny, 1826	0	0	1	0	0	0	0	0	0	0	0
<i>Cibicidoides subhaidingerii</i> (Parr, 1950)	0	0	0	0	0	0	1	1	0	1	1
<i>Elphidium craticulatum</i> (Fichtel & Moll, 1798)	1	1	1	0	0	0	0	1	1	1	
<i>Uvigerina schwageri</i> Brady, 1884	0	0	0	0	0	0	1	1	0	1	1
<i>Heterolepa praecincta</i> (Karrer, 1868)	0	0	1	1	0	0	1	1	1	1	0
<i>Neoponides bradyi</i> (Le Calvez, 1974)	0	0	1	0	1	0	0	1	0	0	0
<i>Operculina ammonoides</i> (Gronovius, 1781) (<i>Neoassilina ammonoides</i> (Gronovius, 1781))	1	1	1	1	0	1	1	1	1	1	0
<i>Operculina complanata</i> (Defrance in Blainville, 1822) (<i>Operculina complanata</i> (Holzmann et al. 2022))	0	1	0	0	0	1	0	1	1	1	0
<i>Operculina discoidalis</i> (d'Orbigny, 1832) (<i>Neoassilina discoidalis</i> (Holzmann et al. 2022))	1	1	0	0	1	1	1	1	1	1	0
<i>Paracibicides edomica</i> (Forderer and Langer, 2018)	0	0	0	0	0	0	0	1	0	1	1
<i>Poroeponides lateralis</i> (Terquem, 1878)	0	0	0	1	0	0	0	1	0	0	0

<i>Planorbulinella larvata</i> (Parker & Jones, 1865)	0	0	0	0	0	0	0	0	1	1	1
<i>Planostegina operculinoides</i> (Hofker, 1927)	0	0	0	1	0	0	0	0	1	0	0
<i>Pseudorotalia indopacifica</i> (Thalmann, 1935)	1	1	1	1	1	1	1	1	1	1	1
<i>Pseudorotalia schroeteriana</i> (Parker & Jones in Carpenter, 1862)	1	1	1	1	1	0	1	1	1	1	0
<i>Rotalinoides gaimardii</i> (d'Orbigny in Fornasini, 1906)	0	0	0	0	1	1	1	1	1	1	0

Supplementary Table S2. The full dataset and the taxon averages of Oxygen and Carbon isotopes.

Samples	Locality	Depths (m)	$\delta^{13}\text{C}$	std.	$\delta^{18}\text{O}$	std.	Yield % (as CaCO_3)	Taxon Averages							
			‰		‰			$\delta^{13}\text{C}$	$\delta^{18}\text{O}$						
			VPDB		VPDB			VPDB	VPDB						
Miliolina															
<i>Cycloforina granulocostata</i>	MES1	14.5	−0.73	0.05	−2.81	0.09	94.2	−0.26	0.66	−2.57	0.33				
<i>Cycloforina granulocostata</i>	MES5	31	0.21	0.03	−2.34	0.07	90.5								
<i>Quinqueloculina granulocostata</i>	MES24	144	0.12	0.02	−0.21	0.07	95.8								
<i>Quinqueloculina granulocostata</i>	MES22	93	0.45	0.02	−0.34	0.07	92.9								
<i>Quinqueloculina granulocostata</i>	MES25	94	−0.53	0.03	−0.66	0.03	97.6								
<i>Quinqueloculina granulocostata</i>	MES27	92	0.49	0.05	−0.74	0.12	65.1	0.13	0.47	−0.49	0.25				
<i>Quinqueloculina parkeri</i>	MES1	14.5	0.92	0.05	−2.13	0.09	85.8	0.94	0.62	−2.05	0.27				
<i>Quinqueloculina parkeri</i>	MES5	31	0.32	0.07	−1.74	0.10	93.4								
<i>Quinqueloculina parkeri</i>	MES8	34	1.57	0.06	−2.27	0.12	74.4								
Lagenina															
<i>Lenticulina echinata</i>	MES27	92	−0.10	0.03	−1.10	0.06	97.2	0.09	0.33	−0.41	0.65				
<i>Lenticulina echinata</i>	MES24	144	−0.24	0.02	−0.11	0.04	105.3								
<i>Lenticulina echinata</i>	MES25	94	0.51	0.04	−0.78	0.08	85.5								
<i>Lenticulina echinata</i>	MES29	190	0.19	0.03	0.35	0.06	98.0								
<i>Lenticulina vortex</i>	MES27	92	0.49	0.02	−1.17	0.06	96.7								
<i>Lenticulina vortex</i>	MES24	144	−0.20	0.03	−1.48	0.09	76.7	0.29	0.43	−1.20	0.26				
<i>Lenticulina vortex</i>	MES25	94	0.59	0.04	−0.95	0.09	92.1								
<i>Dentalina vertebralis</i>	MES5	31	0.11	0.03	−0.99	0.06	99.3								
<i>Dentalina vertebralis</i>	MES17	84	0.41	0.04	−0.60	0.08	93.1								
<i>Dentalina vertebralis</i>	MES22	93	−0.09	0.04	−0.47	0.06	102.1								
<i>Dentalina vertebralis</i>	MES24	144	0.42	0.06	0.07	0.10	92.4	0.21	0.19	−0.56	0.36				
<i>Dentalina vertebralis</i>	MES25	94	0.23	0.02	−0.52	0.07	97.1								
<i>Dentalina vertebralis</i>	MES27	92	0.18	0.04	−0.83	0.06	98.7								
Rotaliina															
<i>Pseudorotalia indopacifica</i>	MES5	31	0.29	0.03	−0.66	0.09	83.5					0.04	0.23	−0.80	0.80
<i>Pseudorotalia indopacifica</i>	MES8	34	−0.43	0.06	−2.36	0.10	96.2								
<i>Pseudorotalia indopacifica</i>	MES15	68	−0.08	0.02	−1.46	0.06	102.7								
<i>Pseudorotalia indopacifica</i>	MES16	77	0.21	0.03	−1.25	0.07	105.1								
<i>Pseudorotalia indopacifica</i>	MES17	84	0.09	0.03	−0.65	0.07	93.5								
<i>Pseudorotalia indopacifica</i>	MES22	93	0.31	0.02	−0.33	0.05	103.0								
<i>Pseudorotalia indopacifica</i>	MES24	144	−0.24	0.04	−0.42	0.05	93.8								
<i>Pseudorotalia indopacifica</i>	MES25	94	0.11	0.02	−0.93	0.06	96.6								
<i>Pseudorotalia indopacifica</i>	MES29	190	0.02	0.02	0.70	0.06	106.0								
<i>Pseudorotalia indopacifica</i>	MES27	92	0.15	0.02	−0.64	0.04	100.5								
<i>Rotalinoides gaimardii</i>	MES16	77	0.94	0.06	−1.22	0.05	100.5								
<i>Rotalinoides gaimardii</i>	MES17	84	0.97	0.05	−0.94	0.11	95.1								
<i>Rotalinoides gaimardii</i>	MES27	92	1.24	0.03	−1.18	0.09	95.3								
<i>Rotalinoides gaimardii</i>	MES22	93	0.89	0.03	−1.34	0.09	88.0								
<i>Rotalinoides gaimardii</i>	MES25	94	0.97	0.06	−1.63	0.12	88.5								

<i>Rotalinoides gaimardii</i>	MES24	144	1.10	0.02	-0.63	0.06	82.7	1.02	0.13	-1.16	0.34
<i>Pseudorotalia schroeteriana</i>	MES1	14.5	-1.18	0.04	-3.62	0.03	103.2				
<i>Pseudorotalia schroeteriana</i>	MES5	31	-0.33	0.06	-3.45	0.08	102.1				
<i>Pseudorotalia schroeteriana</i>	MES8	34	0.57	0.02	-2.60	0.06	90.3				
<i>Pseudorotalia schroeteriana</i>	MES5	31	0.70	0.03	-1.65	0.03	96.3				
<i>Pseudorotalia schroeteriana</i>	MES16	77	0.33	0.03	-1.83	0.06	78.3				
<i>Pseudorotalia schroeteriana</i>	MES27	92	-0.27	0.02	-1.52	0.06	88.0				
<i>Pseudorotalia schroeteriana</i>	MES22	93	0.48	0.03	-1.40	0.06	97.5				
<i>Pseudorotalia schroeteriana</i>	MES25	94	-0.20	0.02	-3.31	0.07	90.4				
<i>Pseudorotalia schroeteriana</i>	MES24	144	0.61	0.04	-1.14	0.04	99.0	0.08	0.62	-2.28	0.97

Supplementary Table S3. Data of Oxygen and Carbon water isotopic composition.

Site	Date	Depth (m)	T (°C)	$\delta^{18}\text{O}$ ‰, VSMOW	std.	$\delta^{13}\text{C}$ ‰, VPDB	std.
Dolphin Wreck	17 August 2022	24.4	29–30	-0.69	0.10	-0.67	0.07
Pelong Rock	17 August 2022	5	29–30	-0.74	0.11	-0.45	0.05
Bolkiah Wreck	18 August 2022	23.5	30	-0.64	0.05	-0.25	0.03
OilRig 2	18 August 2022	10	30	-0.50	0.08	-0.28	0.03
			Av.	-0.64		-0.41	
			Std.	0.10		0.19	