

SUPPLEMENTARY MATERIAL FOR DATA REPOSITORY

METHODS

$^{40}\text{Ar}/^{39}\text{Ar}$ geochronology

A bulk sample of ~200 g from the spherule-rich layer was gently disaggregated and spherules were concentrated by rolling them on an inclined sheet of paper to separate them from the matrix. Approximately 300 spherules were selected for freedom from visible alteration based on uniform, vitreous luster. The selected spherules were then rinsed ultrasonically for 15 minutes in 5% HF, after which many revealed veins or surface coatings of whitish alteration and were rejected from further consideration. Twenty five of those remaining were selected for dating. These ranged from 0.8 to 1.2 mm in size, ranged from dark beige to olive green, revealing scalloped surfaces after the HF rinse. The spherules were irradiated for 10 hours in the Cd-lined CLICIT facility of the Oregon State University TRIGA reactor along with the Fish Canyon sanidine (FCs-EK) standard (Morgan et al., 2014) in the 250-500 μm fraction. Neutron fluence parameters (J-values) for each of the two sample positions were computed by planar interpolation between four bracketing standard positions. Spherules were analyzed individually by stepwise degassing in 9-15 steps with a defocussed CO_2 laser, and Ar ion beams were measured by peak hopping with a MAP 215C mass spectrometer using procedures essentially identical to those of Renne et al. (2013). Mass discrimination (1.01151 ± 0.00114^1 per Da) was monitored via analysis of 48 air pipettes interspersed with the unknowns. Backgrounds were measured between every 3 unknowns and their mean and standard deviation were used for corrections. Decay and interference

¹ All uncertainties stated herein are at the 1σ level unless stated otherwise.

corrections were those of Renne et al. (2013). Ar isotope data corrected for radioactive decay, mass discrimination, and backgrounds are given in Table DR1. Age spectra are shown in Figures DR1(a) and DR1(b). Ages were calculated using the optimization calibration of Renne et al. (2011), facilitating comparison with $^{40}\text{Ar}/^{39}\text{Ar}$ ages for the Beloc tektites, Chicxulub melt rocks and Ir anomaly at the K/Pg boundary (Renne et al., 2013) and with U/Pb ages relevant to the K/Pg boundary (Clyde et al., 2016; Schoene et al., 2015).

Micropaleontology

For the planktic foraminiferal analysis, 74 washed samples were studied (Table DR2). Standard disaggregating techniques employing diluted H_2O_2 was applied but the technique did not result due to heavily lithified samples poor in organic matter. Subsequently, samples were processed using two disaggregation techniques: one using a solution with 80% acetic acid and 20% H_2O for 4 to 6 hours, and another using a 2M NaOH solution for 24 hours. Samples were washed through a 63 μm sieve. When the quantitative analysis was possible, the samples were split with an Otto-microsplitter to obtain a representative aliquot of at least 300 specimens per sample. Some specimens were examined under the scanning electron microscope Zeiss MERLIN FE-SEM at the Electron Microscopy Service of the Universidad de Zaragoza (Spain). In addition, thin sections from samples 16.40, 19.50, 19.70 and 19.85 were studied, in order to determine the presence or absence of the planktic foraminiferal assemblages described previously by Bermúdez et al. (2016). The most relevant planktic foraminiferal species identified in the Gorgonilla section are illustrated in Figure DR2.

Palynology

Twenty one samples were selected for palynological analysis from the Gorgonilla section, focusing on the interval 18.70–20.73 m and spanning the spherule bed (Table DR3). The palynological processing was carried out at the Swedish Museum of Natural History following standard procedures outlined in Vajda et al. (2004) and Ferrow et al. (2011). A total of 7–10 g of sediment was processed by first adding HCl (concentration 25%) followed by HF (concentration 35%). The residue was mounted in epoxy. Three slides were analysed per sample and all palynomorphs within these three were identified providing presence/absence records. Residues from selected samples were analyzed by Scanning electron microscopy. Taxa identified are shown in Figure DR3.

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SUPPLEMENTARY FIGURES AND TABLES

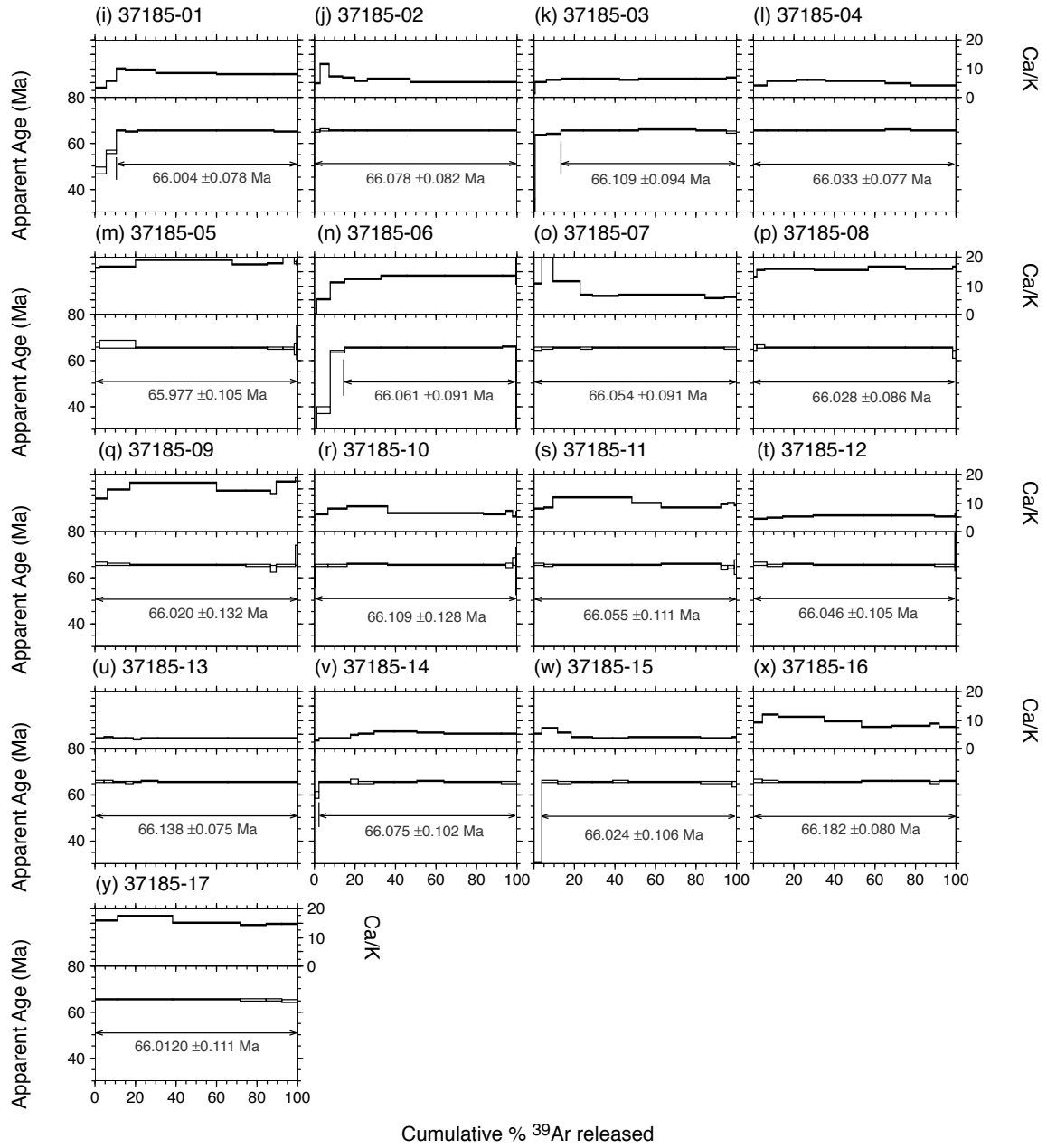


Figure DR1(a). $^{40}\text{Ar}/^{39}\text{Ar}$ age (lower panels) and Ca/K (upper panels) spectra for individual tektites from irradiation position 37185. Plateau ages and uncertainties (σ) are shown with arrows indicating steps defining the plateaux.

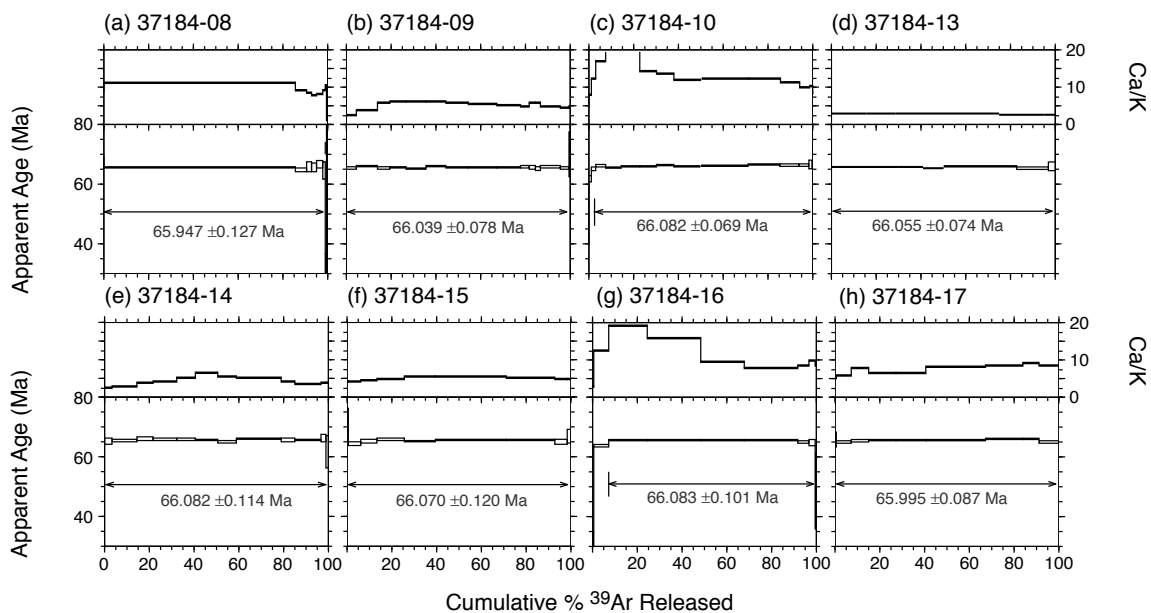


Figure DR1(b). $^{40}\text{Ar}/^{39}\text{Ar}$ age (lower panels) and Ca/K (upper panels) spectra for individual tektites from irradiation position 37184. Plateau ages and uncertainties (σ) are shown with arrows indicating steps defining the plateaux.

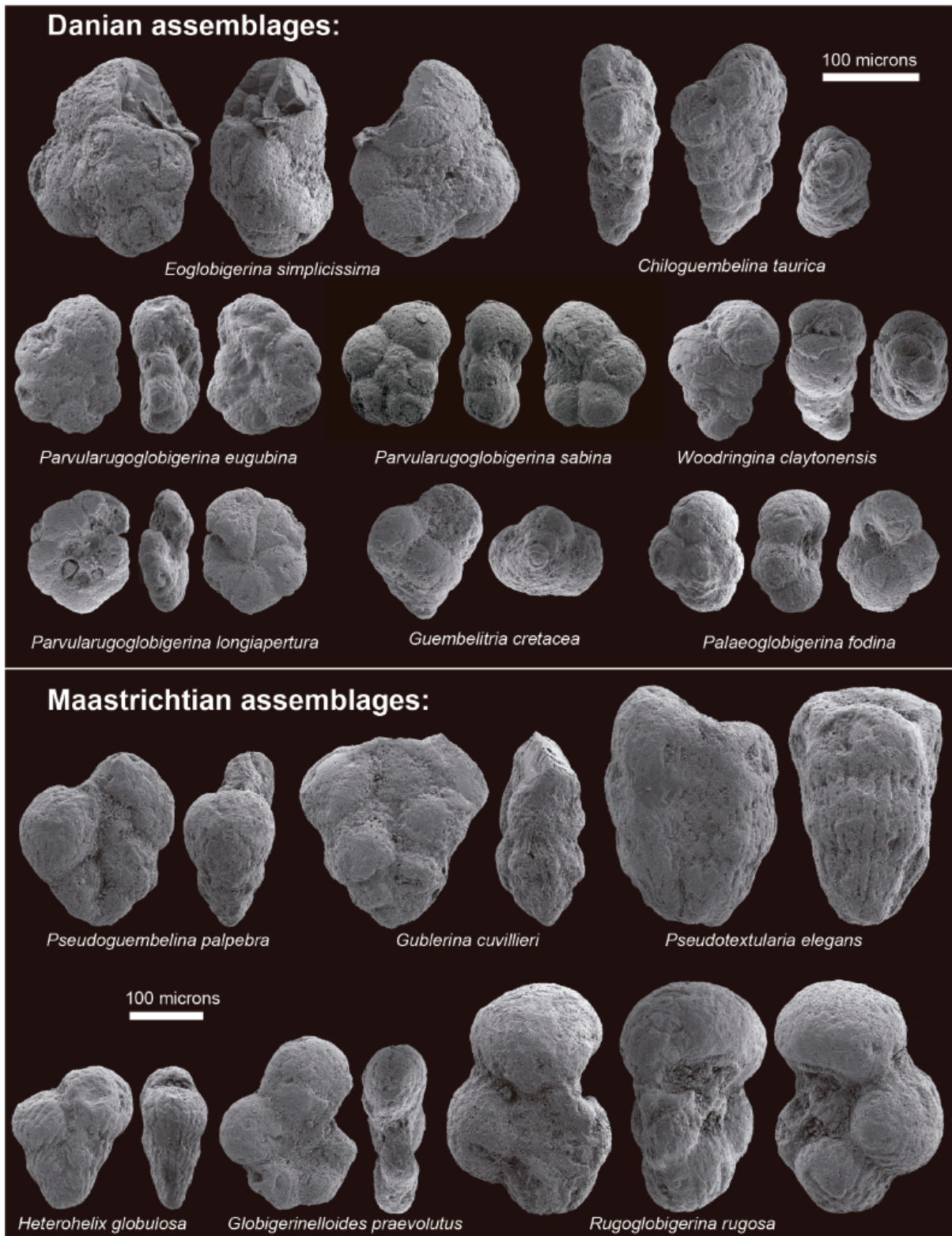


Figure DR2. SEM images of the most relevant planktic foraminiferal species in the Gorgonilla section (scale bar = 100 μ m). **A. Maastrichtian assemblages:** *Pseudoguembelina palpebra* Brönnimann & Brown, G-15.30; *Gublerina cuvillieri* Kikoine, G-15.30; *Pseudotextularia elegans* (Rzehak), G-15.30; *Heterohelix globulosa* (Ehrenberg), G-15.30;

Globigerinelloides praevolutus Petters, G-15.30; *Rugoglobigerina rugosa* (Plummer), G-15.30.

B. Danian assemblages: *Parvularugoglobigerina longiapertura* (Blow), sample G-20.05; *Guembelitra cretacea* Cushman, G-19.98; *Palaeoglobigerina fodina* (Blow), G-20.05; *Parvularugoglobigerina eugubina* (Luterbacher & Premoli Silva), G-20.60; *Parvularugoglobigerina sabina* (Luterbacher & Premoli Silva), G-20.73; *Woodringina claytonensis* Loeblich & Tappan, G-20.05; *Eoglobigerina simplicissima* (Blow), G-20.73; *Chiloguembelina taurica* Morozova, G-20.73.

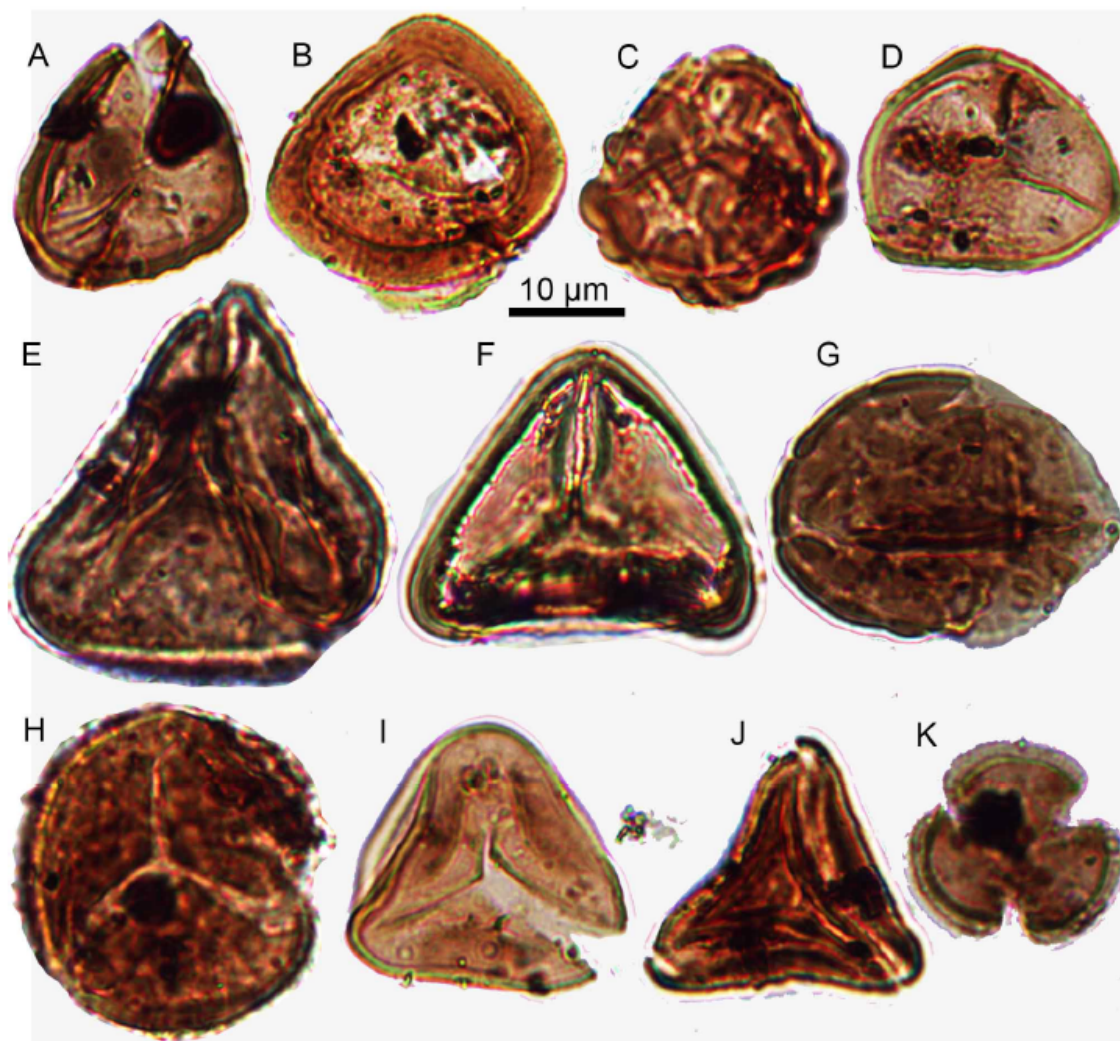


Figure DR3. Representative spores and pollen recovered from the studied succession at Gorgonilla. For all figured specimens, the species and sample number is given. Scale bar = 10 μ m. **A-B.** *Densoisporites velatus* Weyland & Krieger, G-20.18, G-20.73; **C.** *Cingutriteles scanicus* (Vajda), G-20.73; **D.** *Cibotioidites tuberculiformis* (Cookson) Skarby, G-20.73; **E.** *Cyathidites australis* Cooper, G-20.50; **F.** *Deltoidospora toralis* (Leschik) Lund, G-20.73; **G.** *Peromonolites bowenii* Couper, G-20.73; **H.** *Azolla* sp. microspore, G-20; **I.** *Dictyophyllidites harrisii* Cooper, G-20.18; **J.** *Gleicheniidites senonicus* Ross, G-20.18; **K.** *Tricolpites reticulatus* (Cookson) Couper, G-20.18.

Table DR1. Argon isotope data for the Gorgonilla tektites. (See associated Excel file)

Table DR2. Specimen number of planktic foraminiferal species and relative abundance of taxonomic groups for the identification of acme-stages. *Guembelitra* s.l. includes *Guembelitra* and *Chiloguembelitra* species, and *Parvularugoglobigerina* s.l. includes *Parvularugoglobigerina* and *Palaeoglobigerina* species.

TABLE DR2. QUANTITATIVE ANALYSES OF PLANKTONIC FORAMINIFERA (MAASTRICHTIAN/DANIAN) AT GORGONILLA SECTION																		
Sample number	Scale (cm)	Species															Total specimen number	Taxonomic groups for acme-stages
		<i>Pseudocarinina antecursor</i>	<i>Parvularugoglobigerina longispina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	<i>Pyrammina</i>	
G-24.50	457																	
G-23.95	402																	
G-23.80	387																	
G-23.60	367																	
G-23.40	347																	
G-23.00	307																	
G-22.75	282																	
G-22.05	212																	
G-21.80	187																	
G-21.70	177																	
G-21.50	157																	
G-21.30	137																	
G-21.10	117	11	23	9	9	16	17	8	26	2	2	1	1	1	1	1	147	5.7 84.4 6.4
G-20.90	97																	
G-20.80	87																	
G-20.73	80	10	64	34	21	30	31	5	18	2	1	1	1	1	1	1	281	3.6 77.2 13.0
G-20.67	74																	
G-20.60	67	36	54	34	10	46	24	10	22	4	2	3	3	2	2	1	275	2.2 85.2 5.4
G-20.50	57	71	76	29	22	27	17	11	9	1	1	1	1	1	1	1	293	2.1 89.7 7.5
G-20.40	47	100	26	2	35	8	9	9	1	3							227	3.1 85.4 11.9
G-20.33	40	96	65	1	49	9	8	14	2	4							306	3.9 81.6 15.1
G-20.27	34	29	22	5	7	12	8	3	7								117	6.8 79.5 13.7
G-20.21	28																	
G-20.18	25																	
G-20.15	22	20	71	1	11	24	53	36	6	27							288	1.4 87.4 11.9
G-20.10	17	1	9	7	3	1	5	1	5	2							41	7.3 82.9 9.8
G-20.05	12	1	53	30	5	14	66	38	19	37							309	10.1 85.4 4.5
G-19.98	5	5	21	9	4	3	34	13	18	19							305	58.6 41.4 0.3
G-19.93	0																	
G-19.89	4																	
G-19.86	1																	
G-19.85	0																	
G-19.74	4																	
G-19.71	1																	
G-19.70	0																	
G-19.68	-2																	
G-19.63	-7																	
G-19.55	-15																	
G-19.50	-20																	
G-19.45	-25																	
G-19.30	-40																	
G-19.05	-65																	
G-18.64	-106																	
G-18.16	-154																	
G-17.85	-185																	
G-17.45	-225																	
G-17.20	-250																	
G-16.90	-280																	
G-16.75	-295																	
G-16.35	-335																	
G-15.80	-380																	
G-15.30	-440																	
G-14.80	-490																	
G-14.50	-520																	
G-14.10	-560																	
G-13.75	-595																	
G-13.40	-630																	
G-13.10	-660																	
G-12.50	-720																	
G-11.85	-785																	
G-11.20	-850																	
G-10.85	-885																	
G-10.60	-910																	
G-10.35	-935																	
G-9.80	-990																	
G-9.20	-1050																	
G-9.00	-1070																	
G-8.70	-1100																	
G-8.50	-1120																	
G-8.70	-1300																	
G-6.00	-1370																	
G-4.50	-1520																	
G-3.30	-1640																	
Note: Samples G-19.70, G-19.85 and G-19.98 correspond to same microtektite layer sampled in several stratigraphical positions																		
- : No planktonic foraminifera identified																		

Note: Samples G-19.70, G-19.85 and G-19.98 correspond to same microtektite layer sampled in several stratigraphical positions

- No planktonic foraminifera identified

Table DR3. Distribution and absolute abundance data of spores and pollen identified across the spherule bed at the Gorgonilla section.

TABLE DR3. QUANTITATIVE ANALYSES OF SPORES AND POLLEN AT GORGONILLA SECTION (DANIAN)													
Sample number	Scale (cm)	Species											
		<i>Azolla microspore</i> *	<i>Azolla megaspore</i> *	<i>Azolla massulae</i> *	<i>Cibotidites tuberculiformis</i> *	<i>Cingulitoides scanicus</i> *	<i>Cyathidites australis</i> *	<i>Cyathidites minor</i> *	<i>Deltoidospora toralis</i> *	<i>Densoisporites velatus</i> *	<i>Dictyophyllidites harrisi</i> *	<i>Gleicheniidites circinidites</i> *	<i>Gleicheniidites senonicus</i> *
												<i>Peromonolites bowenii</i> *	<i>Lycopodiadites</i> sp. **
													<i>Tricolpites reticulatus</i> ***
G-20.80	87	-	-	-	-	-	-	-	-	-	-	-	-
G-20.73	80	4	-	5	4	2	3	-	3	3	-	1	4
G-20.67	74	-	-	-	-	-	-	-	-	-	-	-	-
G-20.60	67	-	-	-	-	-	-	-	-	-	-	-	-
G-20.50	57	-	-	-	-	-	3	-	2	-	-	2	-
G-20.40	47	-	-	-	-	-	-	-	-	-	-	-	-
G-20.33	40	-	-	-	-	-	-	-	-	-	-	-	-
G-20.27	34	-	-	-	2	-	-	-	-	-	-	-	-
G-20.21	28	-	-	-	-	-	-	-	-	-	-	-	-
G-20.18	25	-	1	-	-	-	-	-	2	4	3	1	5
G-20.15	22	2	6	-	-	-	-	-	1	-	-	-	-
G-20.10	17	1	-	-	-	-	-	2	-	-	-	1	2
G-20.05	12	-	-	-	2	-	2	3	4	-	-	2	-
G-19.98	5	-	-	-	-	-	-	-	-	-	-	-	-
G-19.93	0	-	-	-	-	-	-	-	-	-	-	-	-
G-19.89	4	-	-	-	-	-	-	-	-	-	-	-	-
G-19.86	1	-	-	-	-	-	-	2	-	-	-	-	-
G-19.85	0	-	-	-	-	-	-	-	-	-	-	-	-
G-19.74	4	-	-	-	-	-	-	-	-	-	-	-	-
G-19.71	1	-	-	-	-	-	-	-	-	-	-	-	-
G-19.70	0	-	-	-	-	-	-	-	-	-	-	-	-

Note: Samples G-19.70, G-19.85 and G-19.98 correspond to same microtektite layer sampled in several stratigraphical positions.

*Fem genus and species, ** *Lycophyte* genus *** Angiosperm species.

-No spores and pollen identified.