Pim Kaskes, Sietze J. de Graaff, Jean-Guillaume Feignon, Thomas Déhais, Steven Goderis, Ludovic Ferrière, Christian Koeberl, Jan Smit, Axel Wittmann, Sean P.S. Gulick, Vinciane Debaille, Nadine Mattielli, and Philippe Claeys, 2021, Formation of the crater suevite sequence from the Chicxulub peak ring: A petrographic, geochemical, and sedimentological characterization: GSA Bulletin, https://doi.org/10.1130/B36020.1.

Supplemental Material

Figure S1. Workflow for digital image analysis of thin sections within the M0077A suevite sequence, exemplified with thin section BTS-23 (58_1_30_32 at a depth of 671.44 mbsf). (A) Photoscan. (B) Panorama taken under plane-polarized light. (C) Panorama taken under cross-polarized light. (D) Qualitative multi-element µXRF map showing the distributions of Fe, Si, Ca, and K. (E) Semi-quantitative single-element µXRF heatmap showing the relative abundance of Ca. A digital segmentation is applied based on this base map because of the large contrast between carbonate clasts (very enriched in Ca, hence the green to red colors), non-carbonate clasts (very depleted in Ca, thus black colors) and the surrounding groundmass (some Ca present, displayed by dark blue to light blue colors). (F) Results from the first digital segmentation based on RGB thresholding, showing the distribution of carbonate clasts, non-carbonate clasts and groundmass (GRM). (G) Component map after the second segmentation, which was based on a detailed petrographic examination (using the overviews in B and C) and manual regrouping of the different clasts. This resulted in the subdivision of carbonate clasts into primary carbonate clasts (PCC) and reacted carbonate clasts (RCC). The non-carbonate clasts were subdivided into vitric melt clasts (VMC), microcrystalline melt clasts (MMC), felsic basement clasts (FBC), mafic basement clasts (MBC), and silica mineral clasts (SMC). The petrographic and geochemical characteristics of these various clast types are further explained in the 'Results' section. (H) One of the final quantitative results from the digital image analysis is the modal abundance of the various clast types and the groundmass within the sample, as is shown here using the same colors as in G. In addition, an extensive database of particle parameters (size, shape, sorting etc.) is generated for each clast and clast type, as is shown here with the size distribution of vitric melt clasts inside BTS-23. Overviews of the modal abundances and particle parameters for the M0077A suevite sequence can be found in Figs. 10-11.

Figure S2. Halfcore photograph with a petrographic and µXRF overview of the transition between brecciated impact melt rock and the non-graded suevite unit in core 84_3 at 715.60 mbsf. The samples (A-D) are positioned on the drill core with their associated depths in mbsf. Samples B and C have been µXRF mapped together so it becomes possible to directly compare the relative abundances of Fe, Si, Ca, and K between the samples, as visible in the Fe-Si-Ca-K multi-element µXRF map and the single-element Ca µXRF heatmap. The basal suevite sample shows enriched Ca (and depleted Fe) in the entire groundmass compared to the impact melt rock sample, which shows Ca and Fe concentrated in the schlieren.

Figure S3. Halfcore photograph and µXRF Ca heatmap of samples covering the transition between the non-graded suevite unit and graded suevite unit in core 81_3 at 710.01 mbsf.

Figure S4. Halfcore photograph and µXRF Fe-Si-Ca multi-element map and Ca heatmap of samples covering the transition between the graded suevite unit and the bedded suevite unit in core 41_2 at 620.88 mbsf.

Figure S5. Halfcore photograph and µXRF Fe-Si-Ca-K multi-element map and S heatmap of samples covering the transition between the bedded suevite unit and the transitional unit in core 40_1 at 617.33 mbsf.

Figure S6. Micro XRF overview of representative M0077A suevite thin sections showing combined Fe-Si-Ca multi-element maps (A) and calcium heatmaps (B). Label colors reflect the units from Fig. 2B.

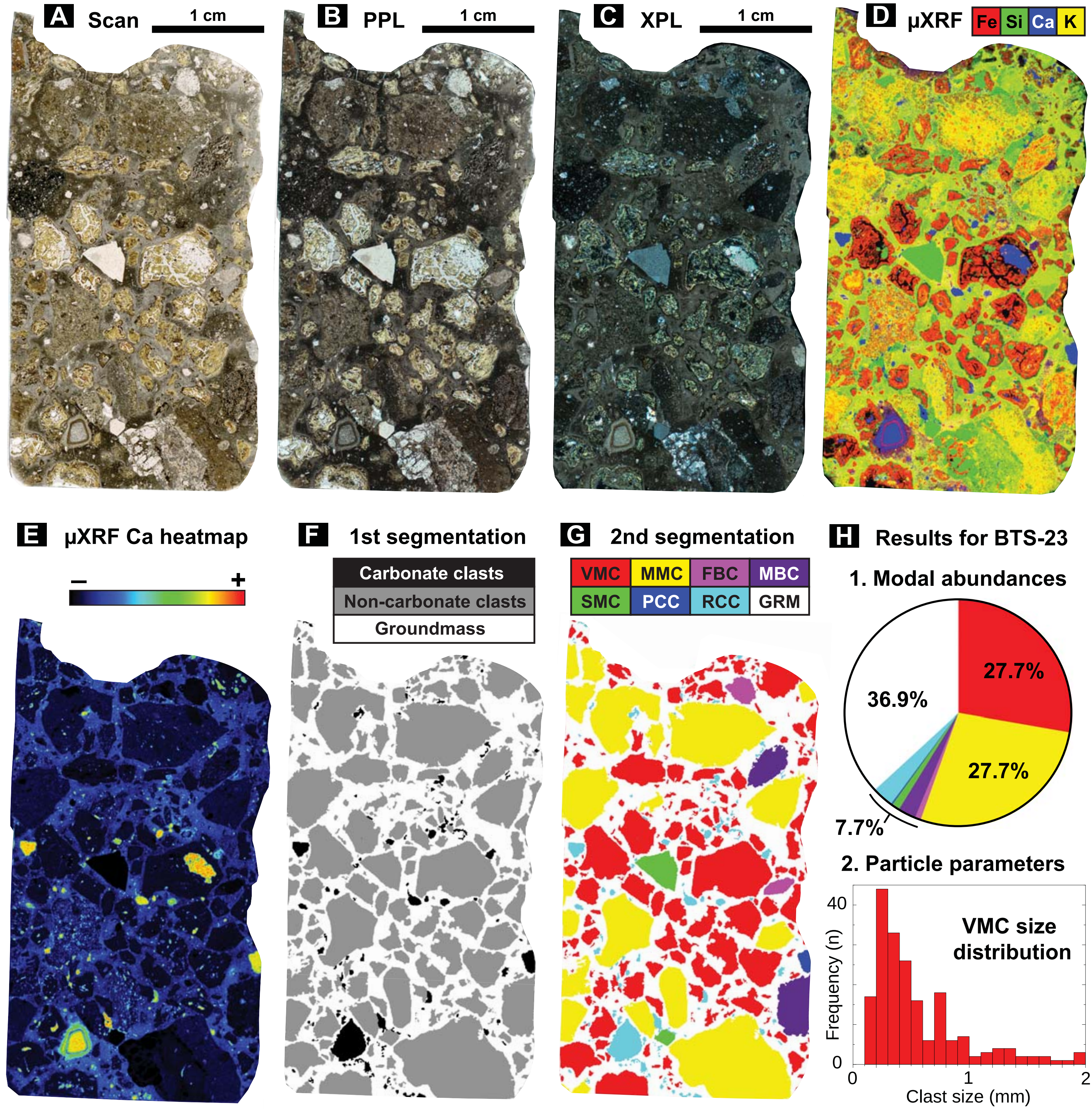
Figure S7. Stratigraphic variations within the M0077A suevite sequence of whole-rock Al_2O_3 (wt%) values (A), bulk sulfur (wt%) values (B), and modal abundances of mineral groups based on bulk XRD measurements (from Gulick et al., 2017).

Table S1. Overview of all the samples used in this study and the associated analytical techniques that were used, both for bulk assemblages (Sheet 1A) and suevite clast types (Sheet 1B).

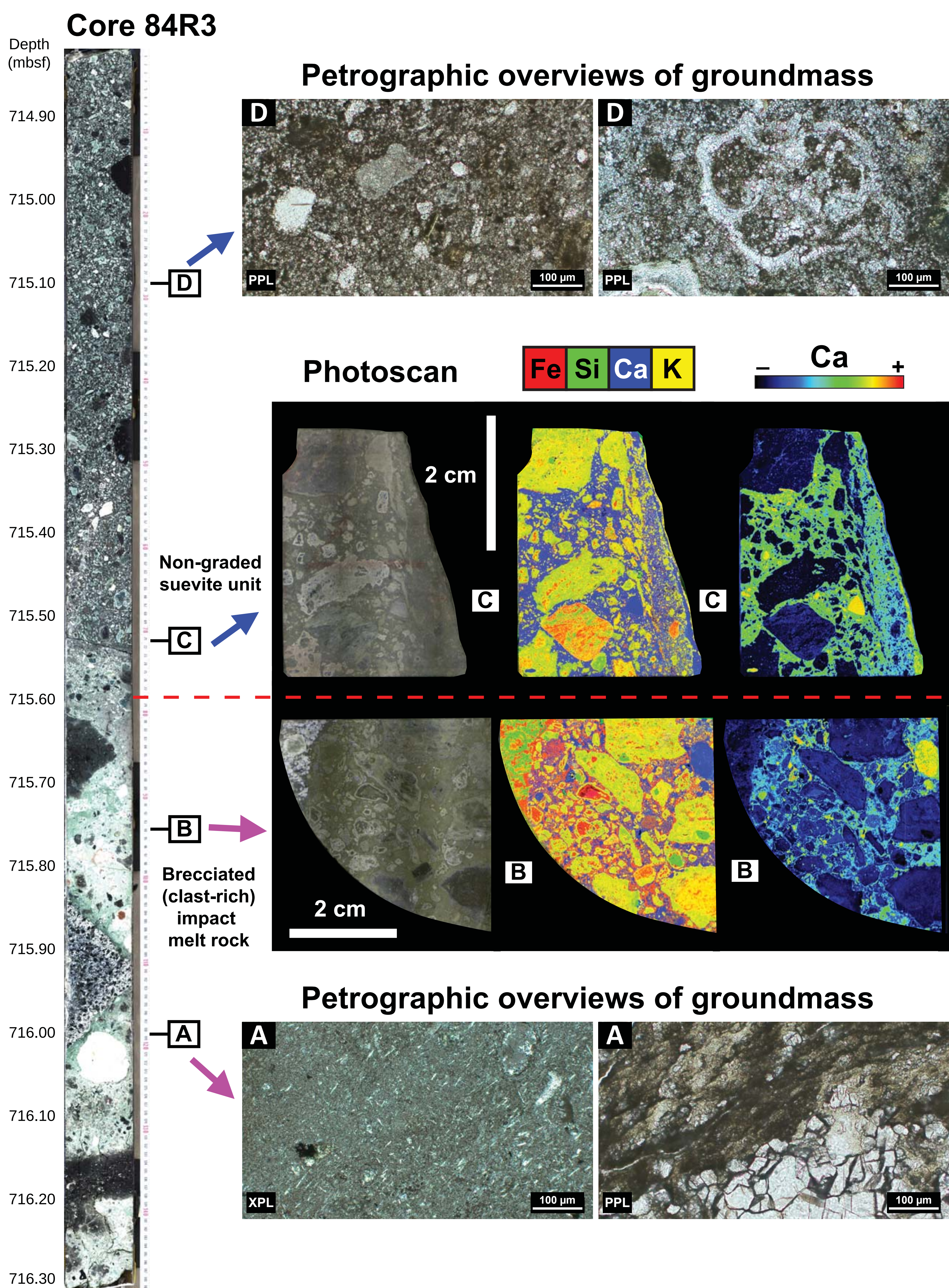
Table S2. Overview of all the geochemical data for both samples and reference material. This includes µXRF data on bulk assemblages (Sheet S2A), µXRF data on suevite clasts (Sheet S2B), bulk ICP-OES data (Sheet S2C), bulk ICP-MS data (Sheet S2D), bulk XRF data (Sheet S2E), bulk INAA data (Sheet S2F), and EMPA data on the suevite groundmass (Sheet S2G).

REFERENCE CITED

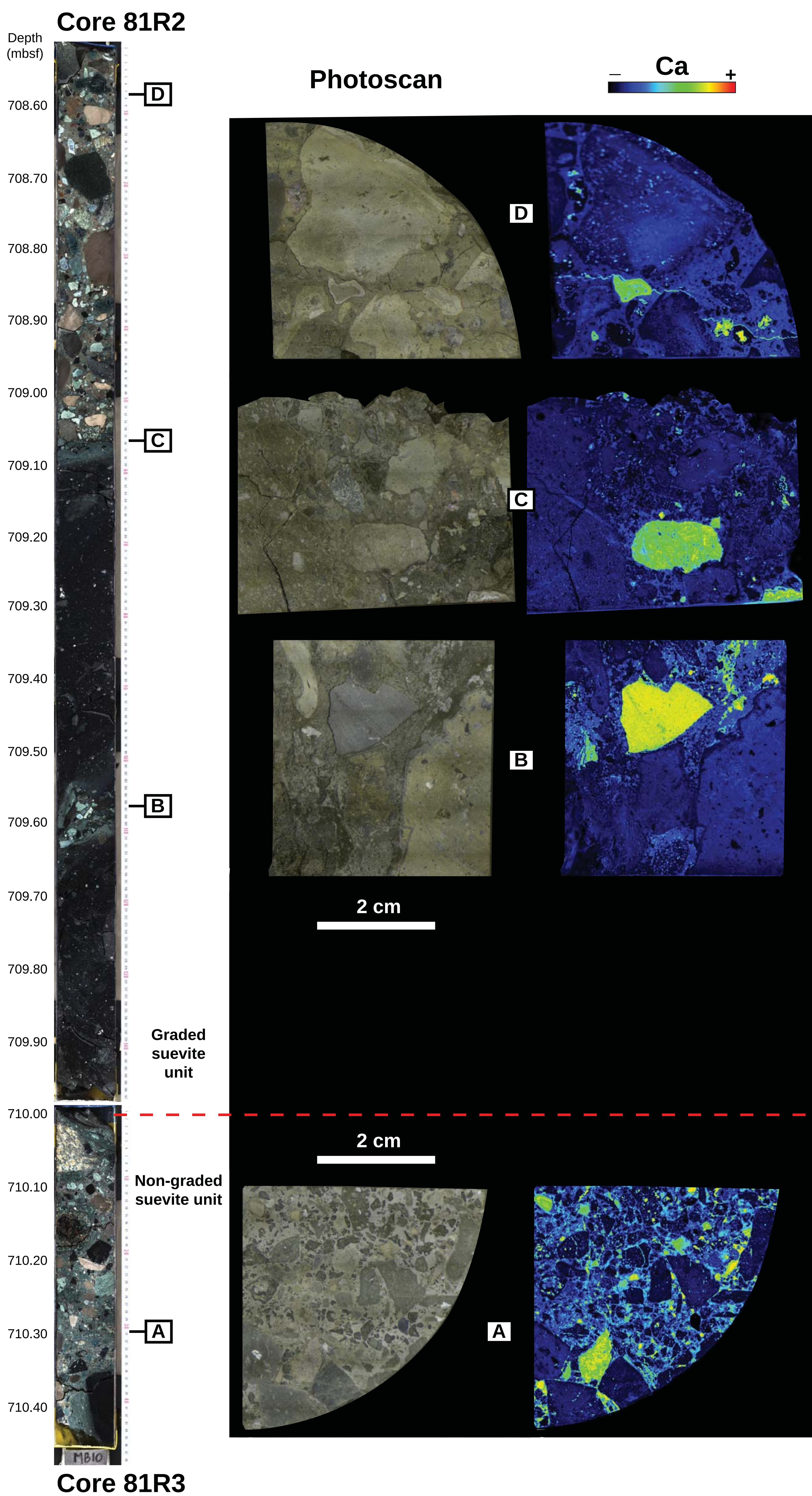
Gulick, S.P.S., Morgan, J., Mellett, C.L., Green, S.L., Bralower, T., Chenot, E., Christeson, G., Claeys, P., Cockell, C., Coolen, M.J.L., Ferrière, L., Gebhardt, C., Goto, K., Jones, H., Kring, D., Lofi, J., Lowery, C., Ocampo-Torres, R., Perez-Cruz, L., Pickersgill, A.E., Poelchau, M., Rae, A., Rasmussen, C., Rebolledo-Vieyra, M., Riller, U., Sato, H., Smit, J., Tikoo, S., Tomioka, N., Urrutia-Fucugauchi, J., Whalen, M., Wittmann, A., Yamaguchi, K., Xiao, L., and Zylberman, W., 2017, Site M0077: Upper Peak Ring, *in* Morgan, J., Gulick, S., Mellett, C.L., Green, S.L., and the Expedition 364 Scientists, Chicxulub: Drilling the K-Pg Impact Crater. Proceedings of the International Ocean Discovery Program, 364: College Station, TX (International Ocean Discovery Program, p. 1–23, https://doi.org/10.14379/iodp.proc.364.106.2017.



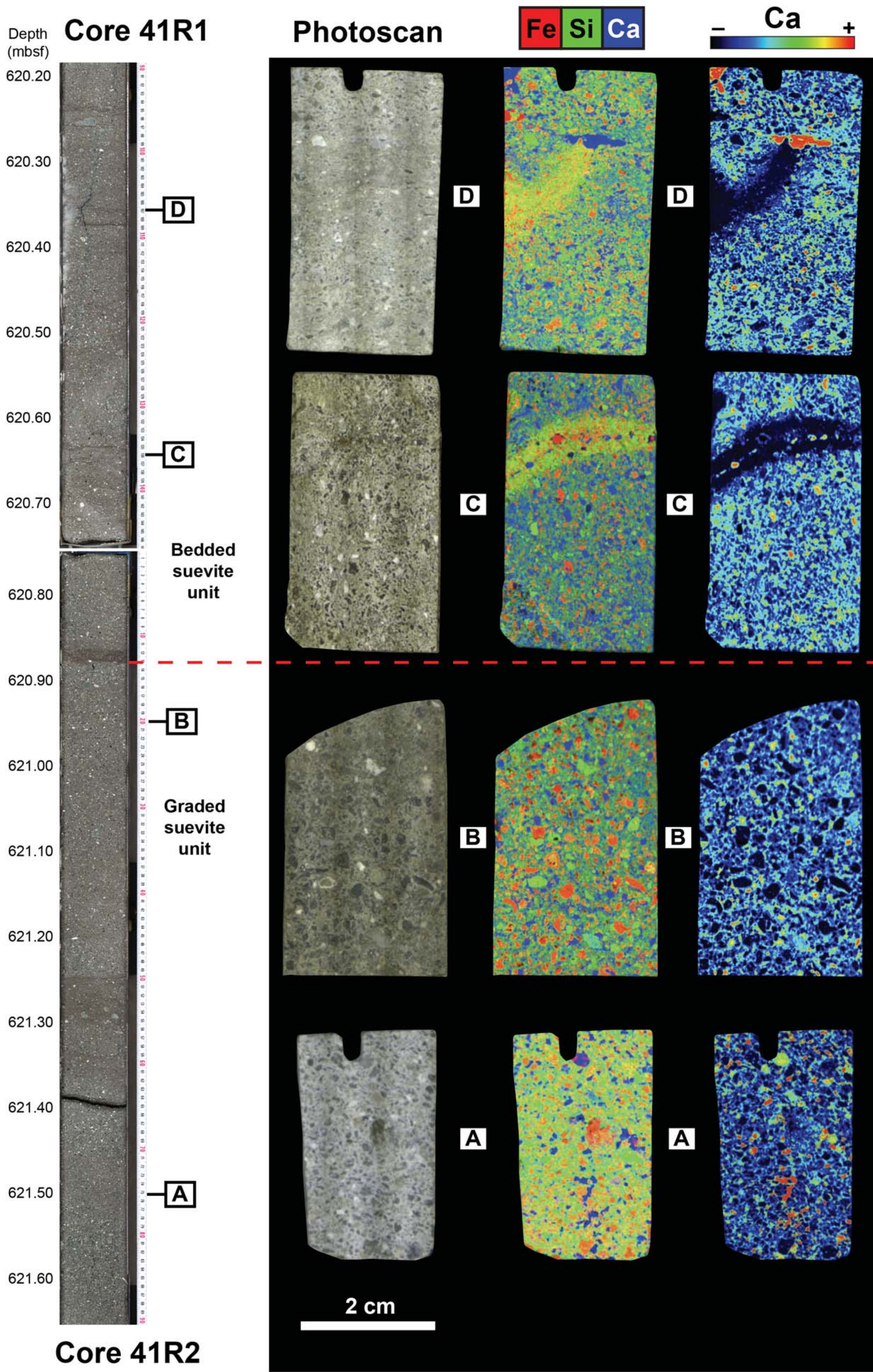
A
Scan
1 cm
B
PPL
1 cm
C
XPL
1 cm
D
µXRF
Fe
Si
Ca
K
E
µXRF Ca heatmap
–
+
F
1st segmentation
Carbonate clasts
Non-carbonate clasts
Groundmass
G
2nd segmentation
VMC
MMC
FBC
MBC
SMC
PCC
RCC
GRM
H
Results for BTS-23
1. Modal abundances
27.7%
27.7%
36.9%
7.7%
2. Particle parameters
VMC size distribution
Frequency (n)
40
0
0
1
2
Clast size (mm)

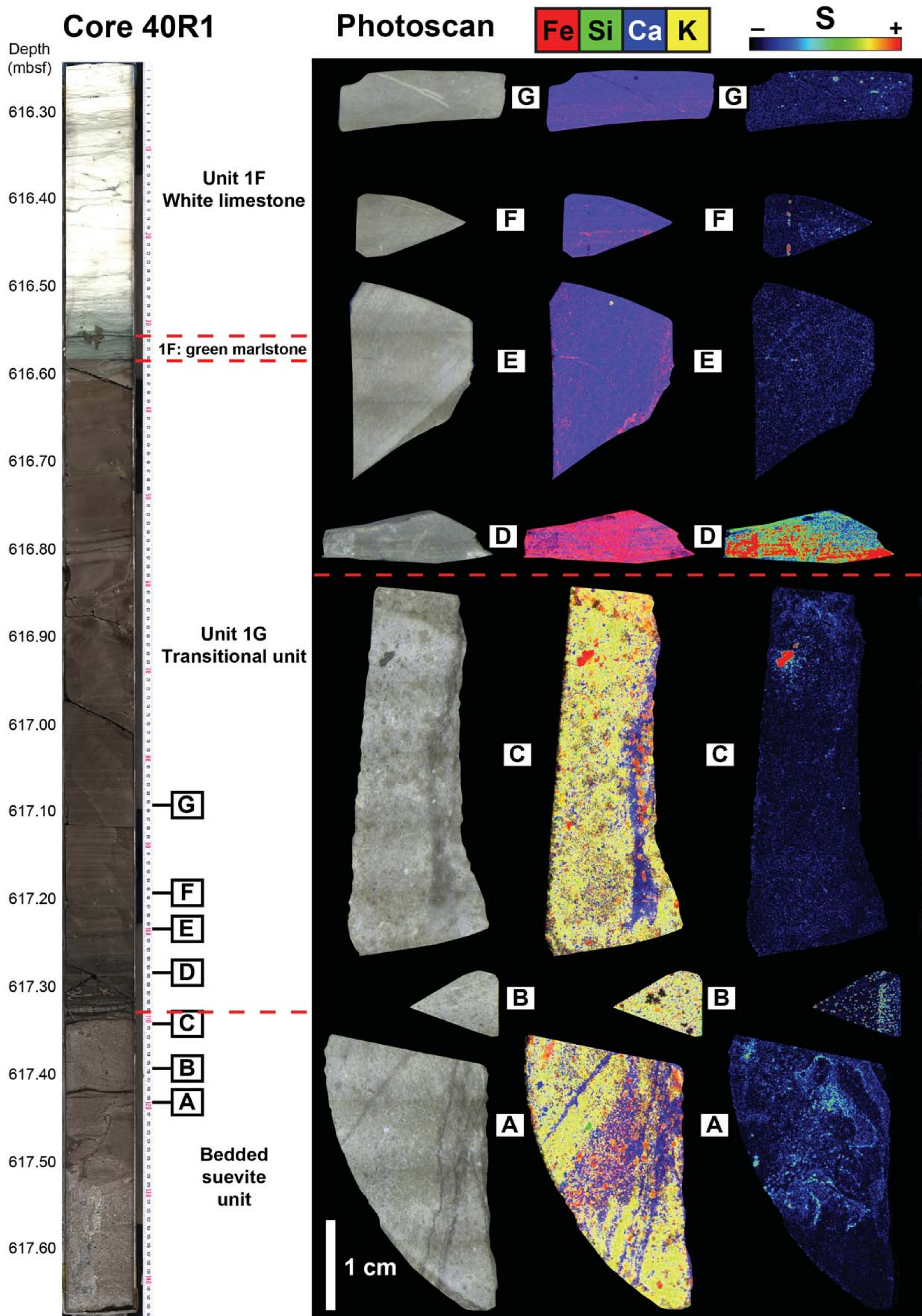


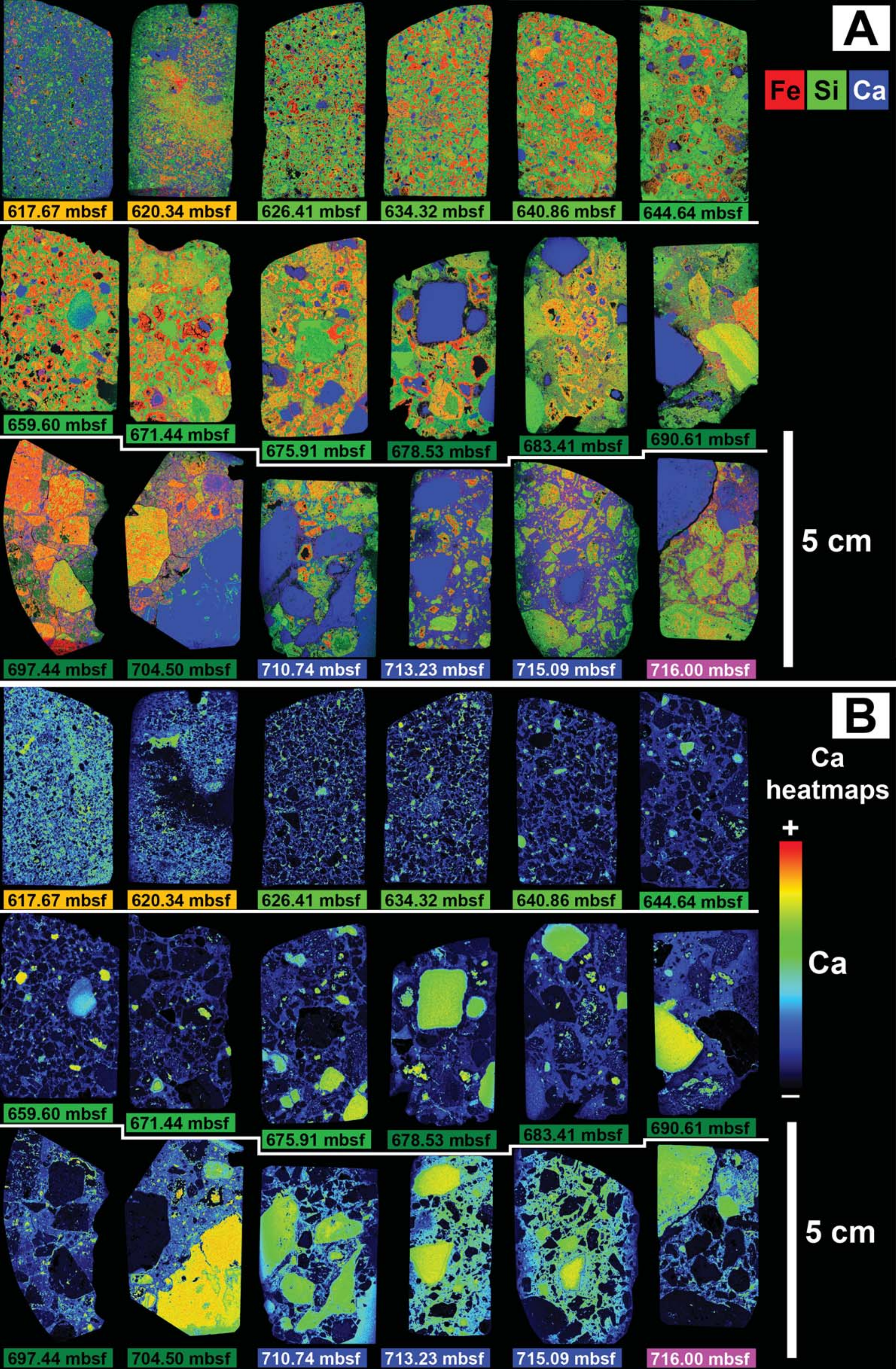
Core 84R3
Depth (mbsf)
714.90
715.00
715.10
715.20
715.30
715.40
715.50
715.60
715.70
715.80
715.90
716.00
716.10
716.20
716.30
Petrographic overviews of groundmass
D
PPL
100 µm
Photoscan
Fe Si Ca K
Ca
–
+
2 cm
Non-graded suevite unit
C
B
Brecciated (clast-rich) impact melt rock
Petrographic overviews of groundmass
A
XPL
PPL

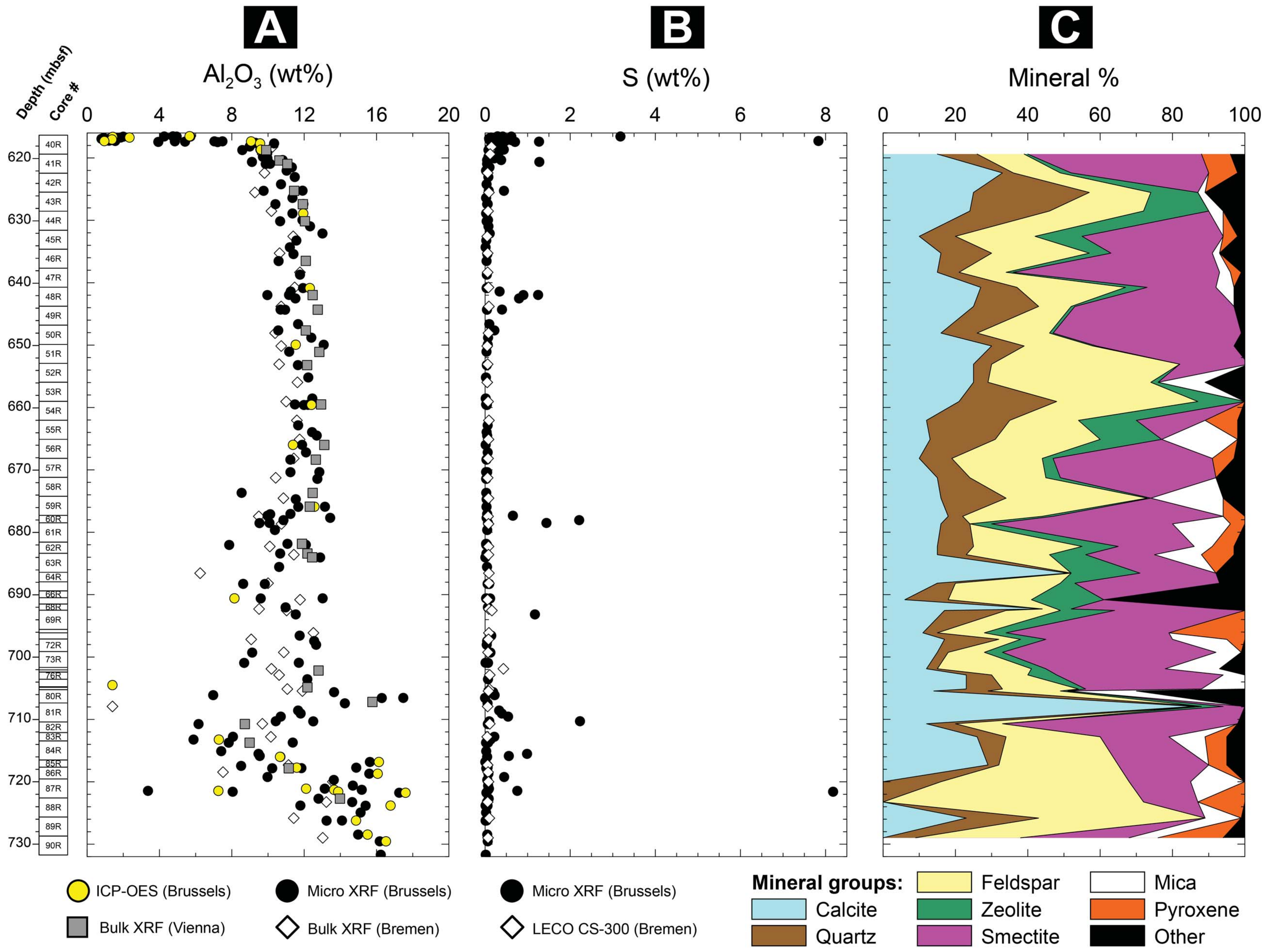


Core 81R2
Depth (mbsf)
708.60
708.70
708.80
708.90
709.00
709.10
709.20
709.30
709.40
709.50
709.60
709.70
709.80
709.90
710.00
710.10
710.20
710.30
710.40
D
C
B
A
Graded suevite unit
Non-graded suevite unit
Photoscan
Ca
–
+
2 cm
2 cm
Core 81R3


Depth (mbsf)
Core 41R1
Photoscan
Fe Si Ca
Ca
–
+
620.20
620.30
620.40
620.50
620.60
620.70
620.80
620.90
621.00
621.10
621.20
621.30
621.40
621.50
621.60
D
C
B
A
Bedded suevite unit
Graded suevite unit
2 cm
Core 41R2


Core 40R1
Photoscan
Fe
Si
Ca
K
S
–
+
Depth (mbsf)
616.30
616.40
616.50
616.60
616.70
616.80
616.90
617.00
617.10
617.20
617.30
617.40
617.50
617.60
Unit 1F
White limestone
1F: green marlstone
Unit 1G
Transitional unit
Bedded suevite unit
G
F
E
D
C
B
A
1 cm


A
Fe
Si
Ca
617.67 mbsf
620.34 mbsf
626.41 mbsf
634.32 mbsf
640.86 mbsf
644.64 mbsf
659.60 mbsf
671.44 mbsf
675.91 mbsf
678.53 mbsf
683.41 mbsf
690.61 mbsf
697.44 mbsf
704.50 mbsf
710.74 mbsf
713.23 mbsf
715.09 mbsf
716.00 mbsf
5 cm
B
Ca heatmaps
+
Ca
–
617.67 mbsf
620.34 mbsf
626.41 mbsf
634.32 mbsf
640.86 mbsf
644.64 mbsf
659.60 mbsf
671.44 mbsf
675.91 mbsf
678.53 mbsf
683.41 mbsf
690.61 mbsf
697.44 mbsf
704.50 mbsf
710.74 mbsf
713.23 mbsf
715.09 mbsf
716.00 mbsf
5 cm



A
B
C
Al2O3 (wt%)
S (wt%)
Mineral %
Depth (mbsf)
Core #
ICP-OES (Brussels)
Micro XRF (Brussels)
Micro XRF (Brussels)
Bulk XRF (Vienna)
Bulk XRF (Bremen)
LECO CS-300 (Bremen)
Mineral groups:
Calcite
Quartz
Feldspar
Zeolite
Smectite
Mica
Pyroxene
Other