SUPPLEMENTARY DATA

SM1. Samples description

Sampling was based on the size of the boulders and stable position, single stage of exposure, continuous exposition in the same position (not shifting), no coverage; minimal surface of weathering or erosion (karren encased for at maximum 0.5 cm).

The samples VB3a, VB3c, VB14 were taken on the Mt. Peron slope at different altitude, VB2 on the right bank of the Cordevole, in the Vedana area and VB12, VB13a and VB13b come from the southernmost part of the deposits, in the Roe Alte sector.

The main characteristics of the dated samples are here reported.

VB2. The sample comes from a grey metric boulder on the right bank of Cordevole river. The rock belongs to Calcari Grigi Group and had a network of black calcite veins. Thin section shows that the rock is a peloidal packstone, with micritic matrix. It is possible to recognize fragments of echinoderm, bivalves, spicules of sponges, algae, foraminifers and peloids.

VB3a. The sample comes from a metric boulder of Upper Rosso Ammonitico Fm. on the left side of Cordevole River, at the foothill of Mt. Peron, 300 m over the Peron village. The sample is a pinkish packstone with nodular structure and fragments of Saccocoma.

VB3c. The sample comes from a decametric boulder of Fonzaso Fm. on the left side of Cordevole River, at the foothill of Mt. Peron, 300 m over the Peron village. The boulder is next to the VB3a sample but is way bigger. On this section the sample appears to be a bioclastic peloidal packstone with fragment of echinoderm, spicules of sponges, bivalve and calcareous algae.

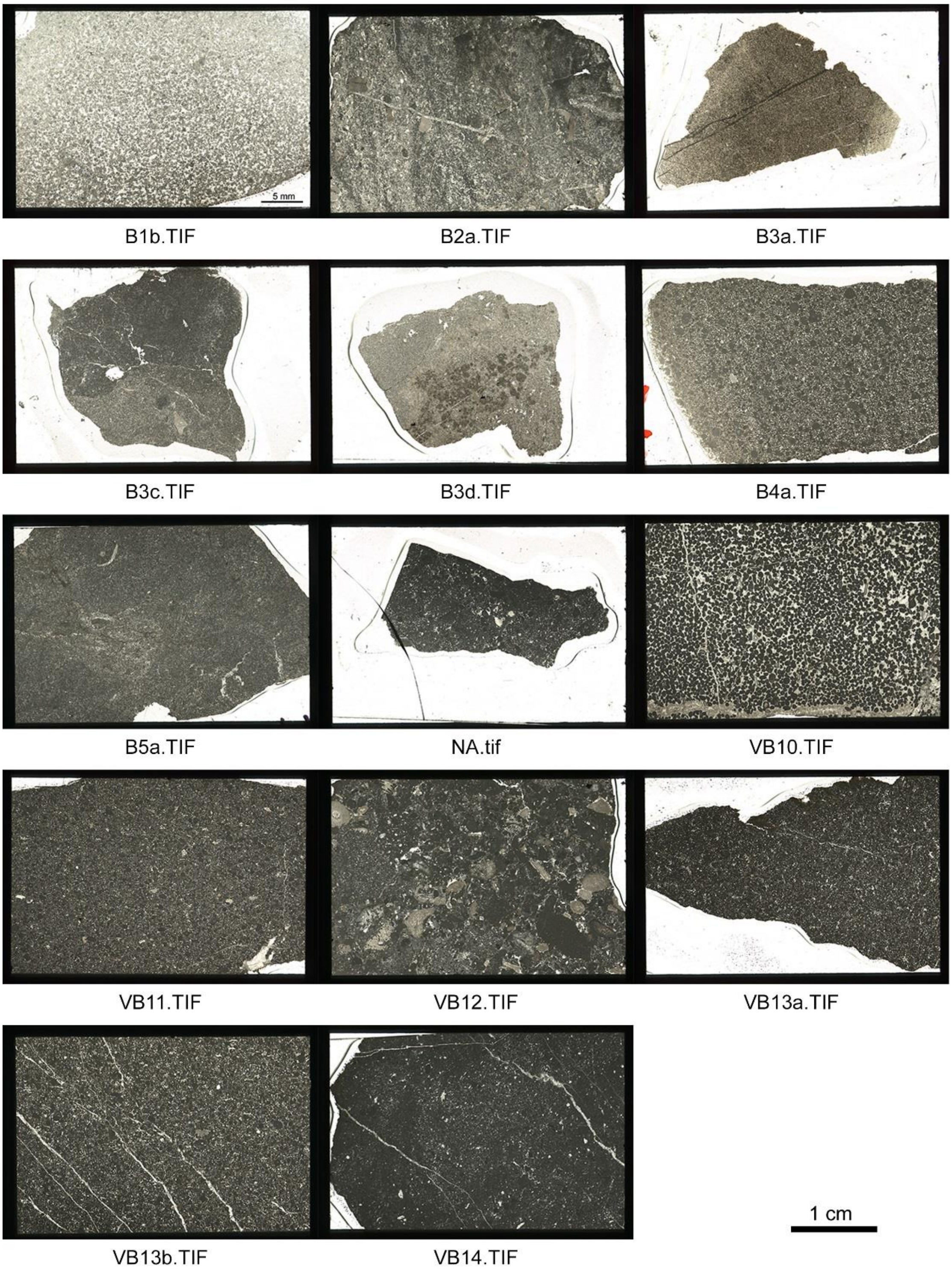
VB12. Sample comes from a grey Vajont limestone metric boulder with evident crinoids and algae situated in the further part of Roe Alte deposits. Thin section shows a packstone with fragment of echinoderm, bryozoan and algae, subordinately bivalves, peloid, and foraminifers. Note that oolites still show a very well preserved radial structure.

VB13a. Sample comes from a decametric boulder of Vajont Fm. white limestone situated in the Roe Alte. Thin section shows a oolitic and bioclastic grainstone. Oolites have a concentric and radial structure, bad preserved due to the advanced state of micritization. Bioclasts are fragments of bivalves, echinoderms, foraminifera and algae.

VB13b. Sample comes from the same boulder the VB13a. Thin section shows an oolitic and bioclastic grainstone. Oolites have a concentric and radial structure, bad preserved due to the advanced state of micritization. Bioclasts are fragments of bivalves, echinoderms, foraminifera and algae.

VB14. Sample comes from a decametric boulder of Calcari Grigi Group. whitish oolitic limestone on the left side of Cordevole River, near samples VB3a and VB3c. Thin section shows a peloidal packstone with ooides and bioclasts. Oolites have a concentric and radial structure, bad preserved due to the advanced state of micritization. Bioclasts are gastropods, different species of foraminifer, bivalve and echinoderm fragments.

SM1a: Photos of the ^{36}Cl dated boulders with sample names indicated (Table 1), locations shown on Fig. 3.



B1b.TIF
B2a.TIF
B3a.TIF
B3c.TIF
B3d.TIF
B4a.TIF
B5a.TIF
NA.tif
VB10.TIF
VB11.TIF
VB12.TIF
VB13a.TIF
VB13b.TIF
VB14.TIF

SM1b: Thin sections from sampled boulders, locations shown on Fig. 3.

SM2. TB1 core: detailed description

Description of TB1 core is presented, from the bottom up, depth in m below surface is given, together with thickness of intervals. Color are given with Munsell color codes.

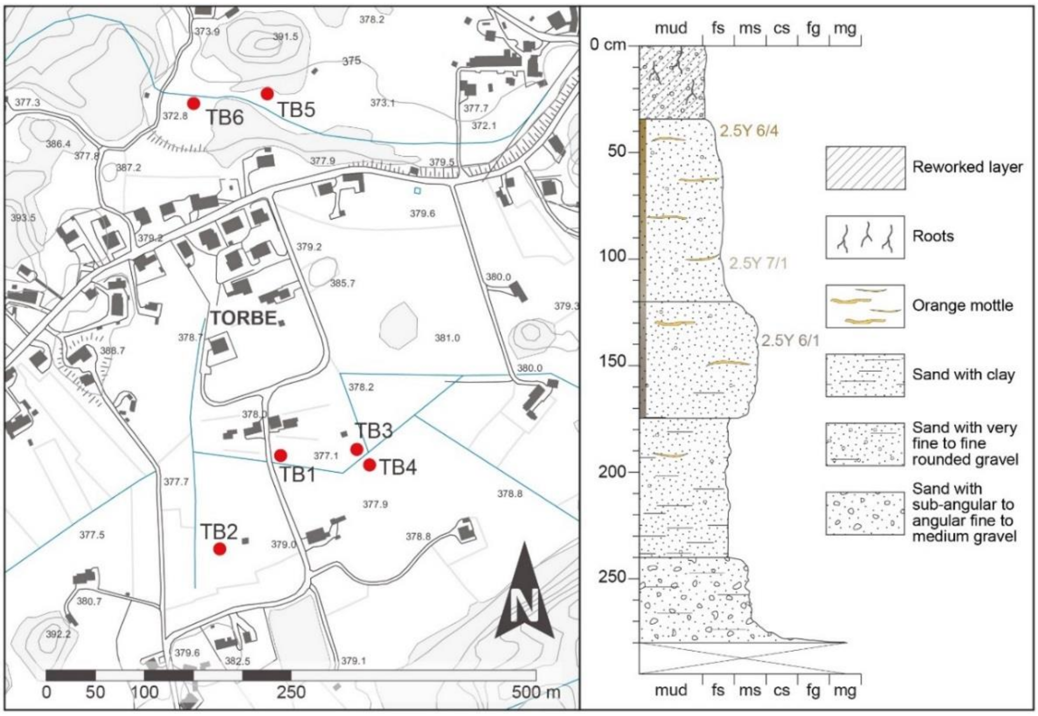
2.40 – 2.80 m b.s. [40 cm]: sub-angular to angular pebbles (0.5 – 2 cm) in a sandy matrix. Below this interval there is presence of gravel, but no recovery was possible, exception made for few clasts made of white granular sandstone.

1.75 – 2.40 m b.s. [65 cm]: fine sand, shifting toward medium sand towards the upper limit, which is gradual. Gradual decrease in the clay content from the bottom up. Orangish mottles, 3 m wide, appear at the depth of 2 m b.s., becoming more frequent upwards.

1.20 – 1.75 m b.s. [55 cm]: medium sand, shifting toward fine sand at the top; upper limit is transitional. Mica particles can be seen in the whole interval, whilst clay is present in the lower portion. Mottles are present, similarly to layer below. Color: 2.5Y 6/1.

0.35 – 1.20 m b.s. [85 cm]: fine sand with silt and sparse rounded pebbles (2 – 3 mm). Color passing from 2.5Y 7/1 to 2.5Y 6/4. Mottles become smaller (i.e. 2 mm wide).

0 – 0.35 m b.s. [35 cm]: sandy to silty interval, with centimeter-sized rounded pebbles. Presence of roots.



SM2a: **Left:** location of the hand cores, see Fig. 3 for location of this frame (figure based on topographic maps freely distributed by Regione Veneto: https://idt2.regione.veneto.it/). **Right:** Stratigraphic log of the TB1 core. Munsell color codes of sediments are reported along the right side.

SM3. XRF

The bulk chemical composition of samples was determined by X-ray fluorescence spectroscopy (XRF) using a WDS sequential Philips PW2400 spectrometer equipped with a 3 kW Rh X-ray tube, 4 filters (Al 200 µm, Brass 100 µm, Pb 1000 µm and Brass 300 µm), 3 collimators (150 µm, 300 µm and 700 µm), 5 analyzing crystals (LiF220, LiF200, Ge111, PE002, TlAP100), 2 detectors (flow counter and scintillator), and the sample changer Philips PW2510 with 30 sample holders. The analyses, performed under vacuum conditions, and using the SuperQ software from Panalytical, were based on calibrations calculated on geological reference standards (Govindaraju, 1994). The samples were crushed in an agate mortar, and the resulting powders were first used to determine the loss on ignition (LOI) heating them in a furnace at 860°C for 20 minutes, and then at 980°C for 2 hours. The calcined powders were then diluted with flux di-lithium tetraborate $Li_2B_4O_7$ (1:10 ratio) and melted with a fluxer Claisse Fluxy (reaching a temperature of about 1150°C) to obtain glass beads for XRF analyses. The results, reported in Table 2, are expressed as percentage concentrations of element oxides for major and minor elements and as parts per million (ppm) for trace elements. In order to include the LOI value (expressed as %) into the sum of major element oxides, analyses were normalised to 100% minus LOI value. Instrumental precision (defined by several measurements performed on the same sample) is within 0.6% relative for major and minor elements, and within 3% relative for trace elements. The XRF accuracy was checked by reference standards (Govindaraju, 1994) and was within 0.5 wt% for Si, lower than 3% for other major and minor elements, and lower than 5% for trace elements. The lowest detection limits of XRF were within 0.02 wt% for Al_2O_3, MgO and Na_2O, within 0.4 wt% for SiO_2, within 0.005 wt% for TiO_2, Fe_2O_3, MnO, CaO, K_2O and P_2O_5 and within a range between 3 and 10 ppm for trace elements.

SM4. ICP-MS

Trace metals and REE were determined by Inductively Coupled Plasma-Mass Spectrometry (Thermo Elemental, mod. X-Series^{II}). Optimisation of the instrumental parameters was performed to achieve best sensitivity, low levels of oxides ($CeO^+/Ce^+ < 2\%$) and double charged ions ($Ba^{++}/Ba^+ < 3\%$). Mass calibration of the quadrupole was also performed. Major instrumental parameters are as follows: plasma power 1.4 kW; gas flows: nebuliser 0.97 L/min, cool 13 L/min and auxiliary 1.0 L/min. The following isotopes were acquired with a dwell time of 10 ms: ^{11}B, ^{27}Al, ^{47}Ti, ^{52}Cr, ^{55}Mn, ^{238}U, ^{147}Sm, ^{157}Gd, ^{232}Th. Five runs (200 sweeps per run) were acquired for each isotope. Multistandard solutions of trace elements and REE were prepared by adequate dilution of the ICP multi-element standard solution for MS (Merck, 29 elements 10 mg L^{-1} and 7 elements 100 mg L^{-1}) and REE multi-element standard solution (Carlo Erba Reagenti, 17 elements 10 mg L^{-1}) and acidified with HNO_3 to a final 2% nitric acid concentration.

	VB2a	**VB3a**	**VB3c**	**VB12**	**VB13a**	**VB13b**	**VB14**
SiO_2	0.23	1.64	1.86	0.04	0.03	0.02	0.05
TiO_2	0.01	0.02	0.02	0.01	0.01	0.01	0.01
Al_2O_3	0.1	0.33	0.42	0.04	0.02	0.03	0.03
Fe_2O_3	0.06	0.19	0.24	0.07	0.02	0.04	0.03
MnO	0	0.07	0.04	0.01	0.01	0.01	0.01
MgO	3.73	0.37	0.37	0.48	0.33	0.31	1.22
CaO	51.21	53.95	53.72	54.75	55.4	55.64	54.79
Na_2O	0	0	0	0.01	0.01	0.01	0.01
K_2O	0.02	0.1	0.12	0.01	0.01	0.01	0.01
P_2O_5	0.03	0.05	0.07	0.02	0.02	0.02	0.01
L.O.I.	*44.23*	*42.93*	*43.04*	*44.01*	*43.77*	*43.79*	*43.53*
Tot	99.62	99.64	99.9	99.46	99.61	99.87	99.67
V	7	8	6	6	<5	<5	<5
Cr	<6	<6	<6	<6	<6	9	<6
Co	<3	<3	<3	<3	<3	<3	<3
Ni	<3	4	5	<3	<3	<3	12
Cu	4	8	7	18	11	11	11
Zn	4	8	9	7	6	6	10
Ga	<5	<5	<5	<5	<5	<5	<5
Rb	6	8	9	3	3	<3	4
Sr	94	145	142	209	219	214	89
Y	4	16	18	7	7	8	<3
Zr	3	6	7	4	<3	<3	3
Nb	<3	<3	<3	<3	<3	<3	<3
Ba	60	59	57	12	16	<10	10
La	<10	19	17	<10	<10	<10	<10
Ce	<10	<10	<10	17	<10	11	<10
Nd	<10	13	17	13	20	15	16
Pb	<5	<5	<5	<5	<5	<5	<5
Th	11	5	6	7	7	7	5
U	<3	<3	<3	<3	<3	<3	<3
^{11}B	1.62	1.83	1.98	1.92	1.52	1.76	0.44
^{147}Sm	0.25	1.37	1.5	0.36	0.29	0.28	0.08
^{157}Gd	0.29	1.45	1.6	0.5	0.43	0.42	0.11
^{232}Th	0.14	0.36	0.44	0.05	0.04	0.03	0.03
^{27}Al	390.52	1071.21	1521				
^{47}Ti	6.47	18.52	20				
^{52}Cr	3.17	<LOD	7				
^{55}Mn	11.41	424.06	240				

SM4a: Chemical composition of analysed rock samples, major oxides in wt %, trace elements in ppm.

SM5. Suppiei section: detailed description

From the bottom up:

- Bedrock consisting of the Bolago Marl: thickness varies from a minimum of 3 m in the northern side to a maximum of 5 m in the southern margin, with an undulated upper limit that roughly corresponds to the strata surface.
- Glacial till, 0.5-to-2 m thick, composed of rounded to sub-rounded decimetric clast (b-axis spanning from 0.5 to 40 cm) of various lithologies (i.e. flysh, limestone/dolostone and volcanic/metamorphic). Clasts show evidence of incisions and striae and little surficial alteration. The deposit is characterized by the presence of a high amount of silty-clayey matrix, brown-to-grey in colour. No evidence of clasts organization. Upper limit is extremely undulated, erosive in origin.
- The uppermost unit is monogenic, being constituted by angular carbonate clast, varying in size from 1 cm to 1 m, with a lot of coarse sandy matrix. Smaller clasts are more abundant than larger ones, that are grouped in the uppermost part of the deposit. This unit is 2-to-20 m thick

SM6. Powder diffraction

Mm-sized samples were crushed and studied by X-ray diffraction on a Philips® PW3710. The goniometer, using conventional Bragg-Brentano parafocusing geometry, was equipped with incident-beam and diffracted-beam Soller slits, a curved graphite diffracted-beam monochromator, and a scintillation counter. The normal-focus Cu-Kai X-ray tube operated at 40 kV and 20 mA. Spectrograms were recorded in the 3-70° 29 range in continuous-scan mode with an increment of 0.02° and a counting time of 0.5 s for each step, and processed by the PC-APD software (Philips®). 28 and d-space values were calculated using the second-derivative algorithm of Savitzky and Golay (1964).