Figures/tables

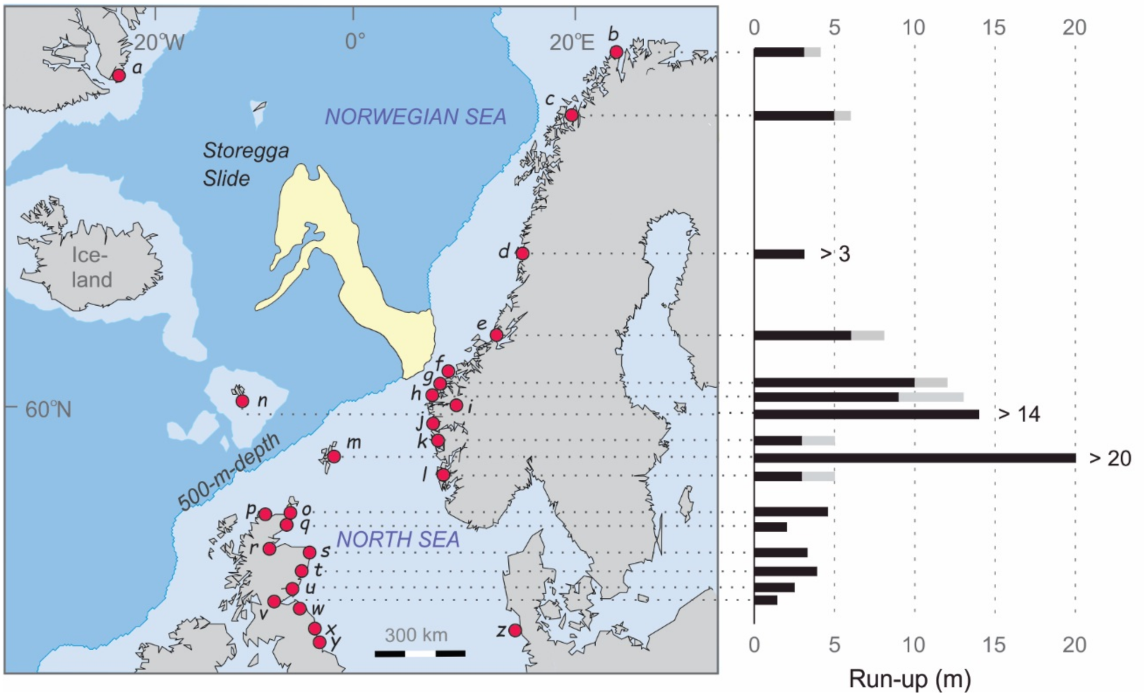

Fig. 1: The Storegga slide in the Norwegian Sea is the largest exposed slide in the world. Red dots show locations of Storegga tsunami deposits. Run-up estimates, from deposits, to the right. Black column shows minimum estimate, grey columns is a maximum estimate of run-up. Letters correspond to the same sites described in Table 1.

Table 1: Field observations of Storegga tsunami deposits and run-up estimates

Index on map	Area	Location	No. of sites	Reference(s)	Outcrop	Lake basin	Marine basin	Estuarine mud	Peat	Run-up (m)	Comments
a	East Greenland	Geographical Society Ø (Loon lake)	1	Wagner et al. (2007)			x			-	Sandy sequence with erosive base in marine silt interpreted as Storegga tsunami deposits. Dated to younger than 8500-8300 yr BP.
b	Northern Norway	Finnmark (Sørøya, Rolvsøya, Nordkinn)	5	Romundset and Bondevik (2011)		x				3-5	Coastal lakes along the outer coast of Finnmark show Storegga tsunami to propagate into the Barents Sea. Deposits in lakes 0-3 m above contemporary sea level. No traces in lake 5 m above contemporary sea level.
c	Northern Norway	Troms (Lyngen)	3	Rasmussen and Bondevik (2006) (Rasmussen et al.)		x	x			> 4.5-6	Storegga tsunami barely inundated lake at 25.2 m a.s.l. Sea level at 21 m a.s.l.
d	Northern Norway	Brønnøy (Hommelstø)	3	Bondevik et al. (2012) Rydgren and Bondevik (2015)			x			> 3	All basins investigated were below sea level at Storegga time, terrestrial plants and peat clasts within tsunami deposits indicate runup > 3 m.
e	Mid-Norway	Bjugn	3	Bondevik et al. (1997)		x	x			6-8	Storegga tsunami overflowed lake at 42 m a.s.l., but not lake at 44 m a.s.l. Contemporary high tide sea level at 35-36 m a.s.l.
f	Western Norway	Sunnmøre (Harøy)	1	Bondevik (2003)	x				x	-	Sandlayer in peat below Tapes beach ridge; was traced in cores landwards of the beach ridge.
g	Western Norway	Sunnmøre (Sula)	6	Bondevik et al. (1997)		x	x			10-12	Storegga tsunami barely inundated lake at 21.5 m a.s.l., but no traces of inundation in lake at 22 m a.s.l. Contemporary sea level at 10-11 m a.s.l.
h	Western Norway	Sunnmøre (Bergsøy, Leinøy)	4	Bondevik et al. (1997)		x	x			9-13	A lake 8-9 m above contemporary sea level show large erosion from Storegga tsunami. Two lakes 12-13 m above contemporary sea level have no traces of inundation.
i	Western Norway	Nordfjord	2	Vasskog et al. (2013)		x				> 1-5	Two lakes at the head of the fjord “Nordfjord” – up to 3 m thick Storegga tsunami deposits. Lakes are 1-5 m above contemporary high tide sea level.
j	Western Norway	Florø	1	Aksdal (1986) Bondevik et al. (1997)		x				-	A bed of gravel, sand and redeposited gyttja, draped with 2 mm silt, dated to 7360±110 ^{14}C years.
k	Western Norway	Hordaland (Austrheim)	5	Bondevik et al. (1997)		x				3-5	A lake at 14 m a.s.l. was clearly inundate by the Storegga tsunami, but not a lake at 15 m a.s.l. Contemporay sea level at 10-11 m a.s.l.
l	Western Norway	Hordaland (Bømlo)	2	Bondevik et al. (1997)		x				3-5	Storegga tsunami deposit in lake at 15 m a.s.l, but not in a bog at ca. 16 m a.s.l. Contemporary sea level at ca 12 m a.s.l.
m	Shetland	Unst, Sullom Voe	9	Bondevik et al. (2005b) Smith et al. (2004)	x	x			x	> 20	Storegga tsunami deposit found in 4 lakes located 0.5-3 m above present high tide level. Sand layer in peat outcrops

											traced to 9.2 m above high tide in the Sullom Voe area. Contemporary sea level 10-15 m below present sea level.
n	Faeroe Islands	Suderøy (Vagur)	1	Grauert et al. (2001)		x				> 14	Lake at 4 m a.s.l. at the head of 5 km long fjord with Storegga tsunami deposits. Contemporary sea level probably 10 m below present sea level.
o	Scotland	Sutherland, Caithness	2	Dawson and Smith (1997) Dawson and Smith (2000) site 7 & 8 in Smith et al. (2004)		x		x	x	4.6	In lower Wick River valley, Caithness, fine sand layer within peat. Tsunami deposits in filled-in lagoon at Strath Halladale in Sutherland.
p	Scotland	Loch Eriboll, Lochan Harvurn	1	Long et al. (2016)	x				x	-	Sand layer in a coastal cliff section of peat.
q	Scotland	Dornoch Firth	3	Site 9-11 in Smith et al. (2004) and references therein.				x		2	Widespread sand layer (Figs. 13 & 14).
r	Scotland	Inner Moray Firth	6	Smith et al. (2004) and references therein. Dawson et al. (1990)				x	x	3.3	Layer of fine sand of marine provenance in estuarine sediments; landwards it rises into peat. One of the sites is an archeological excavation at Inverness, “beach sand” resting upon a Mesolithic horizon with artefacts.
s	Scotland	North-East Scotland	3	Smith et al. (2004) and references therein.				x	x	3.3	Fine medium sand within peat landwards, seawards it continuous into estuarine mud.
t	Scotland	Tayside	6	Smith et al. (2004) and references therein. Dawson et al. (1988)	x			x	x	3.9	Fine sand layer in estuarine deposits around the Montrose basin, continuous into peat landwards. One site (Maryton) is in a cliff exposure (Fig. 15).
u	Scotland	Near St. Andrews (Silver Moss, Craigie)	2	Smith et al. (2004) Dawson et al. (1988)				x	x	2.9	Tapering layer of sand in estuarine deposits that pass into peat up-slope.
v	Scotland	Firth of Forth	2	Smith et al. (2004) and references therein.				x	x	1.4	Sand within estuarine mud, passes into peat at the valley side.
w	Scotland	Near Dunbar (east Lothian)	1	Smith et al. (2004) and references therein.					x	1.3	Sand in peat moss that contains marine and brackish diatoms. Radiocarbon dated to between 7590±60 and 7315±70 ^{14}C yr BP.
x	NE England	Broomhouse Farm	1	Shennan et al. (2000) Smith et al. (2004)					x	ca. 3	Sand horizon of marine provenance within coastal peat moss at Broomhouse Farm.
y	NE England	Howick, Northumberland	1	Boomer et al. (2007)				x		-	30 cm layer of coarse sands and pebbles dated to 8300 yr BP in marine clay/silt.
z	Denmark	Rømø	1	Fruergaard et al. (2015)		x				-	80 cm thick layer of sand and rip-up clasts of organic material.

Table 2: Storegga Slide numbers

Total volume	2400-3200 km^3
Total area, including depositional area	95,000 km^2
Area of slide scar	27,000 km^2
Length of upper headwall	310 km
Water depth at upper headwall	150-400 m
Run-out, including distal turbidites	810 km
Water depth at distalmost deposits	3800 m
Average slope gradient	< 1.0°
Steepest gradient in upper headwall	35°
Max vertical height of upper headwall	250 m
Ages of forams on top of slide deposits	7250±250 ^{14}C years (8150±250 calendar years) BP

(Data from Haflidason et al. (2005); Solheim et al. (2005a); Solheim et al. (2005b)

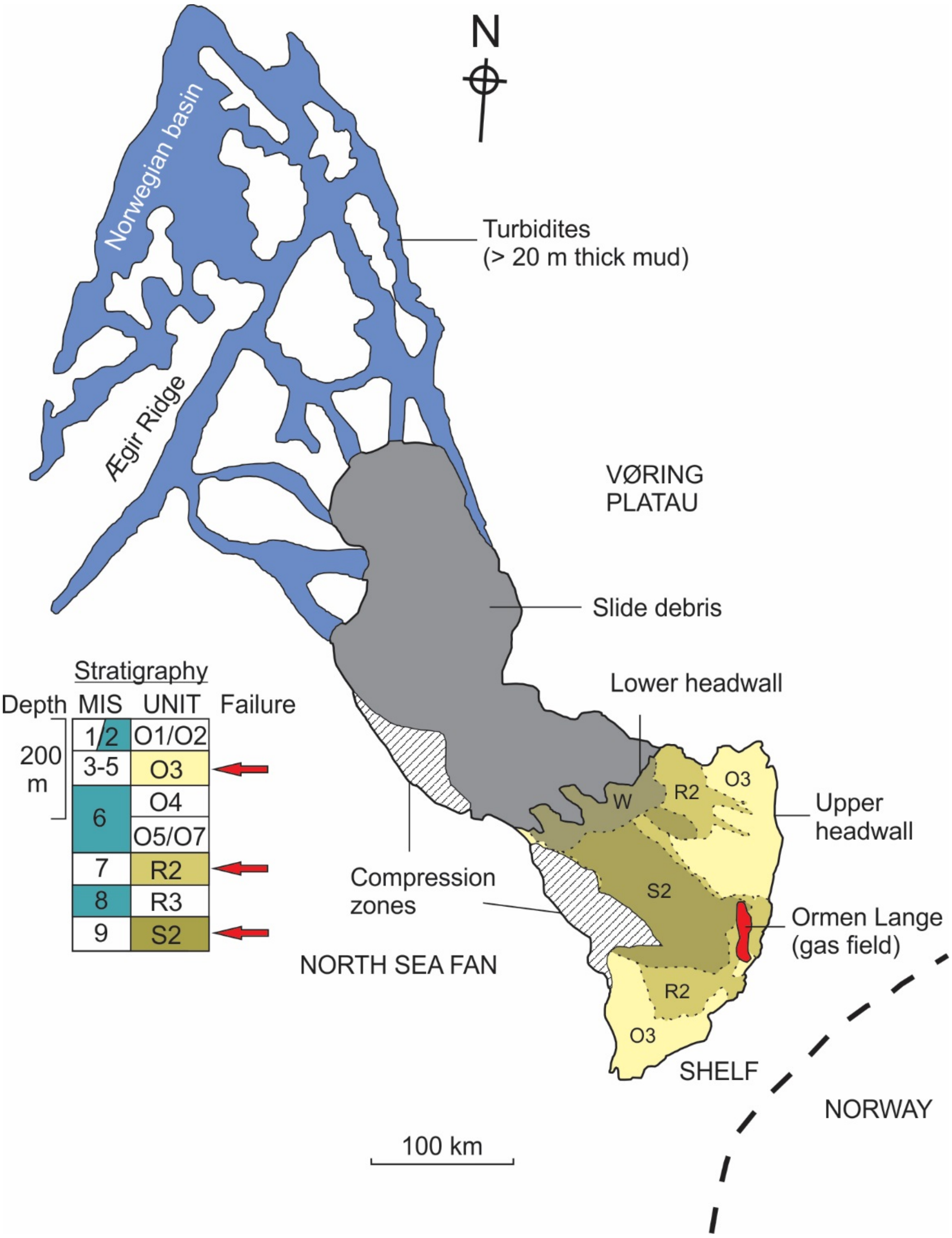

Fig. 2: Outline and deposits of the Storegga Slide. Failure layers in the slide scar area, between the lower and upper headwall, are contourites deposited during interglacials and interstadials (S2, R2 and O3). Stippled lines show minor headwalls. The stratigraphy in the area belongs to the Naust formation (last 3 My) and is subdivided into five units; W, U, S, R and O (youngest) (Berg et al., 2005). To the left a table shows how the units refer to the marine isotope stages. Unit U is not exposed in the Storegga scar area. [Based on Fig. 1 in Haflidason et al. (2005) and Fig. 8 in Bryn et al. (2005).]

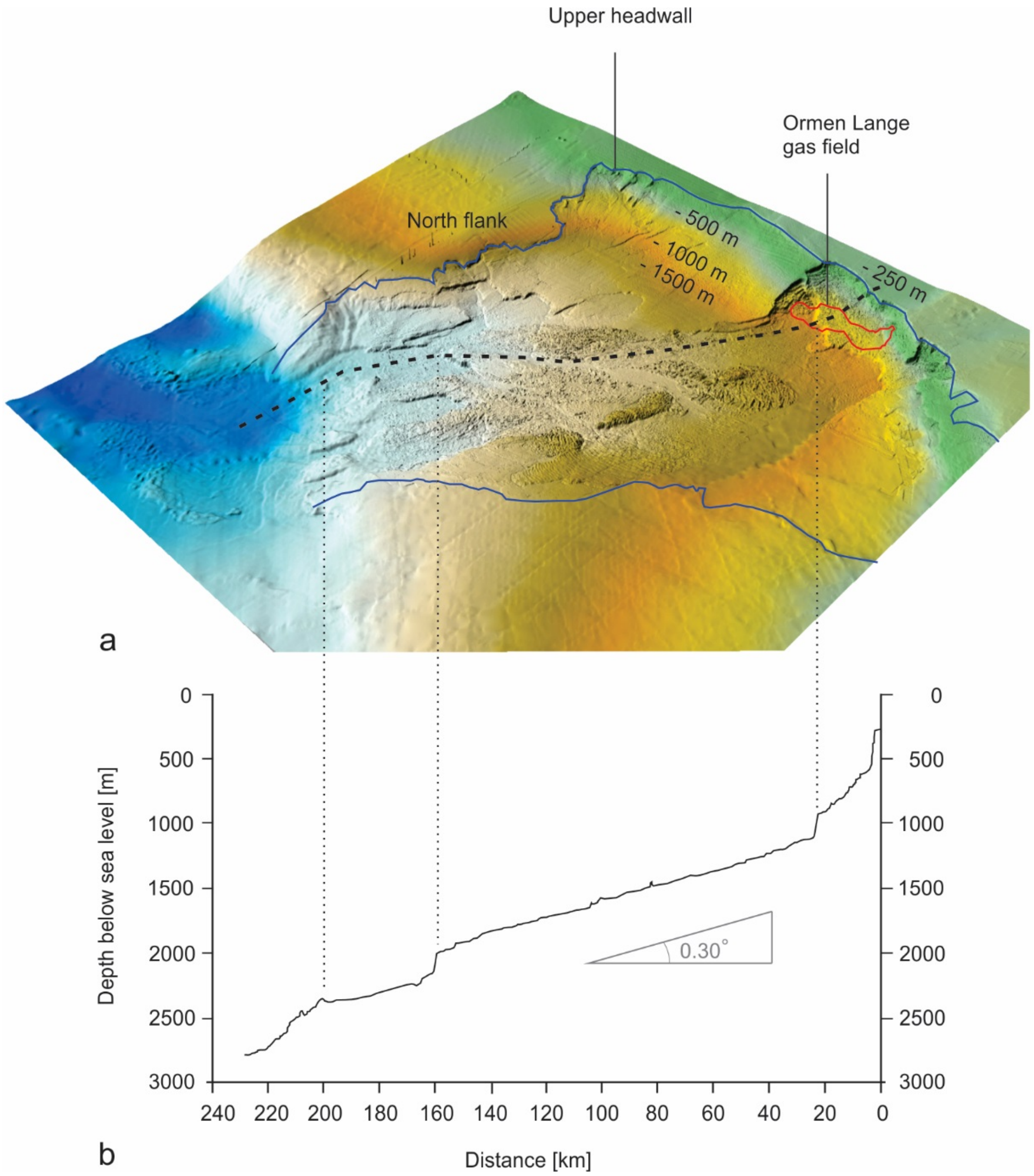

Fig. 3: **a** Bathymetric image of the slide scar. The Ormen Lange gas field is located close to the upper headwall [redrawn from Fig. 2 in Kvalstad et al., 2005]. **b** Depth profile along the stippled line in **a**. The «wavy» line of the slope surface is because of the large blocks in the slide. Note the minor headwalls along the profile – this is a jump to a glide plane at a higher stratigraphic level. A large part of the slope is only 0.3° [redrawn from Fig. 3 in Kvalstad et al., 2005].

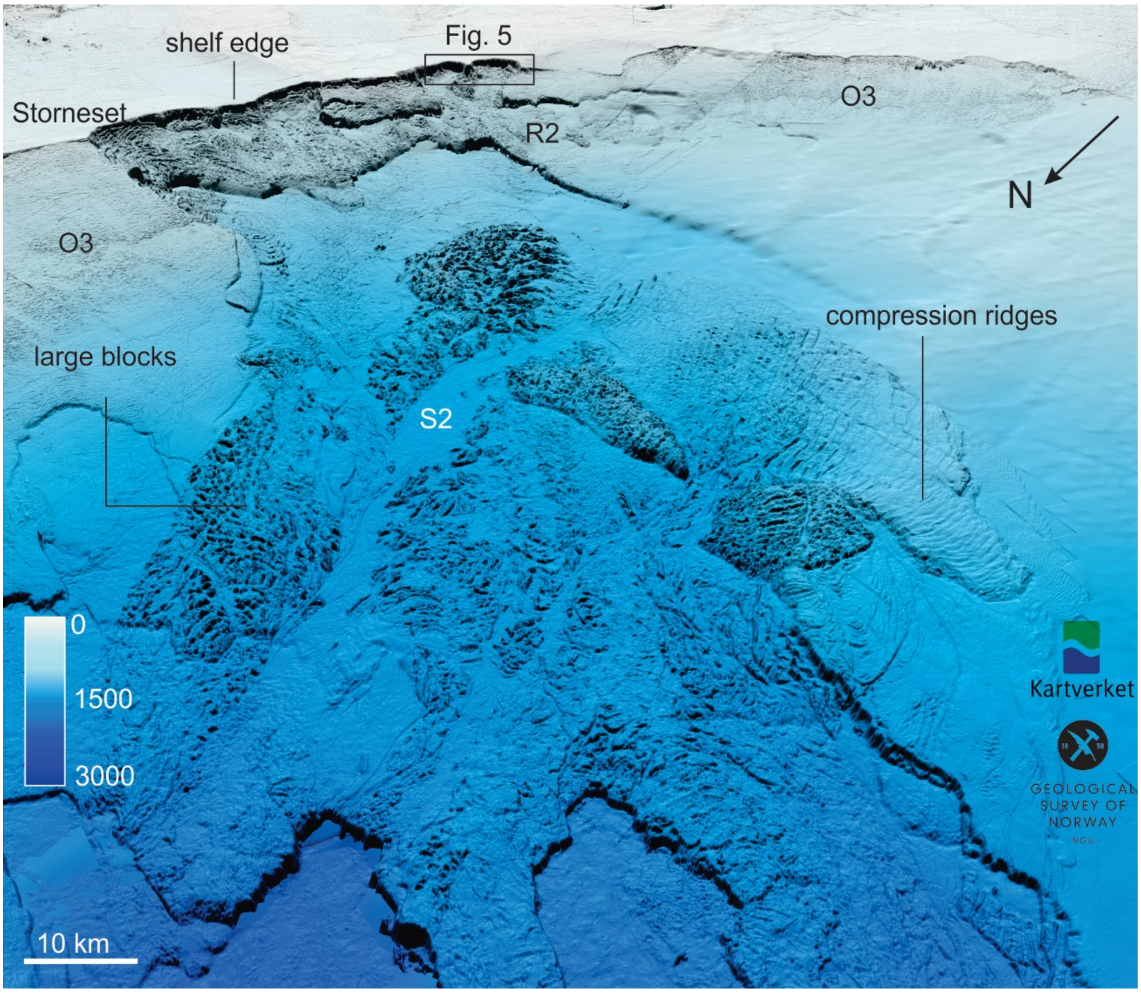

Fig. 4: Bathymetric image of the central part of the slide scar, where the slide cut deepest into the deposits. Units O3, R2 and S2 acted as glide planes. Terrain data: MAREANO/NHS, 3D visualization: MAREANO/NGU (www.mareano.no).

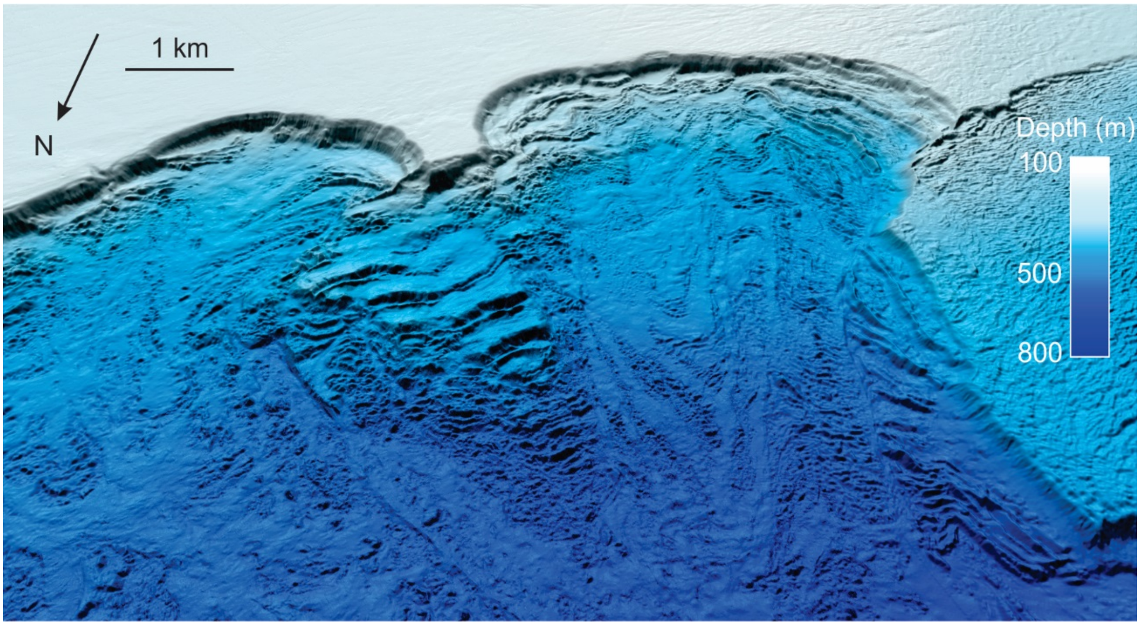

Fig. 5: Focused image of the two "amphitheaters" along the upper headwall. For location see Fig. 4. Terrain data: MAREANO/NHS, 3D visualization: MAREANO/NGU (www.mareano.no).

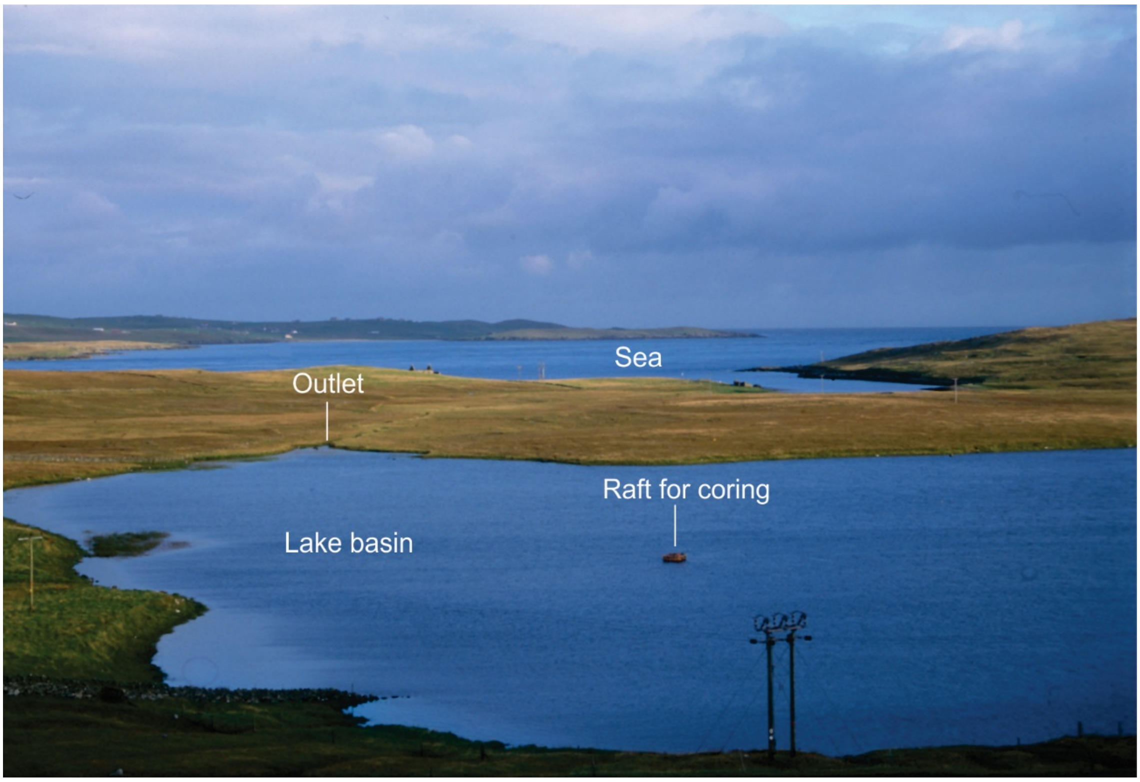

Fig. 6: Coastal lake in Shetland, the Loch of Snarra Voe, on the Island Unst (Fig. 16). The lake is 0.6 m above the present high tide level, but was probably at least 10 m above sea level when Storegga happened. Here we found distinct Storegga tsunami deposits with gravel, sand, rounded rip-up clasts of over-consolidated silt and different types of marine shell fragments. Most erosion was found in cores between the raft and the outlet of the lake (Bondevik et al., 2005b).

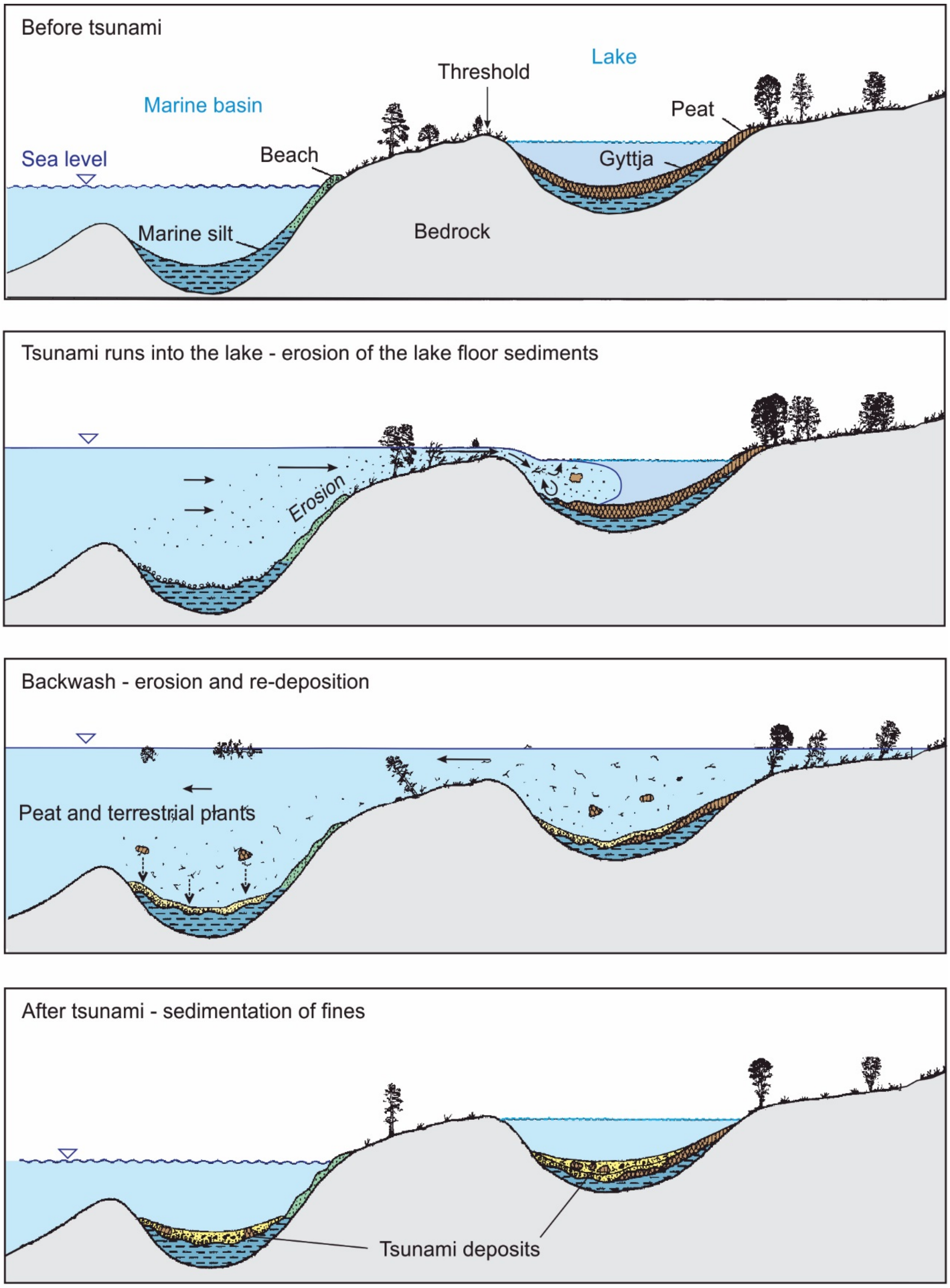

Fig. 7: A sedimentological model for erosion and deposition by a tsunami inundating a marine basin and a lake basin. The model is based on analysis of Storegga tsunami deposits in western Norway [redrawn from Fig. 12 in Bondevik et al., 1997b].

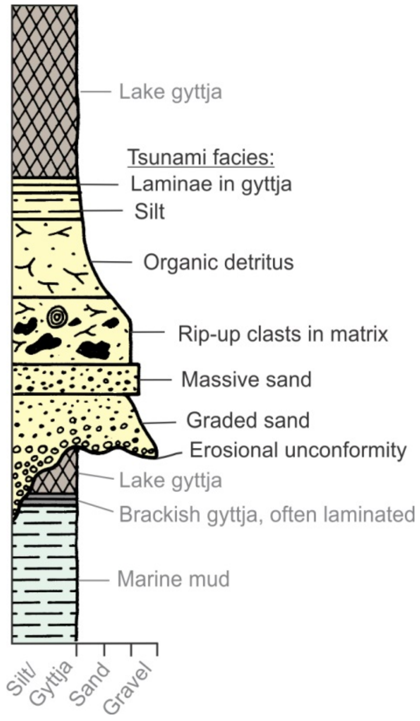

Fig. 8: Description of the Storegga tsunami deposits, given as an idealized, complete facies sequence of tsunami deposits in near shore lakes (yellow). The enclosing sediments are also shown. Note that if graded sand and massive sand occur in the same tsunami sequence they are normally separated by organic deposits (rip-up clasts, detritus or silt). [Based on Fig. 5 in Bondevik et al. (1997)].

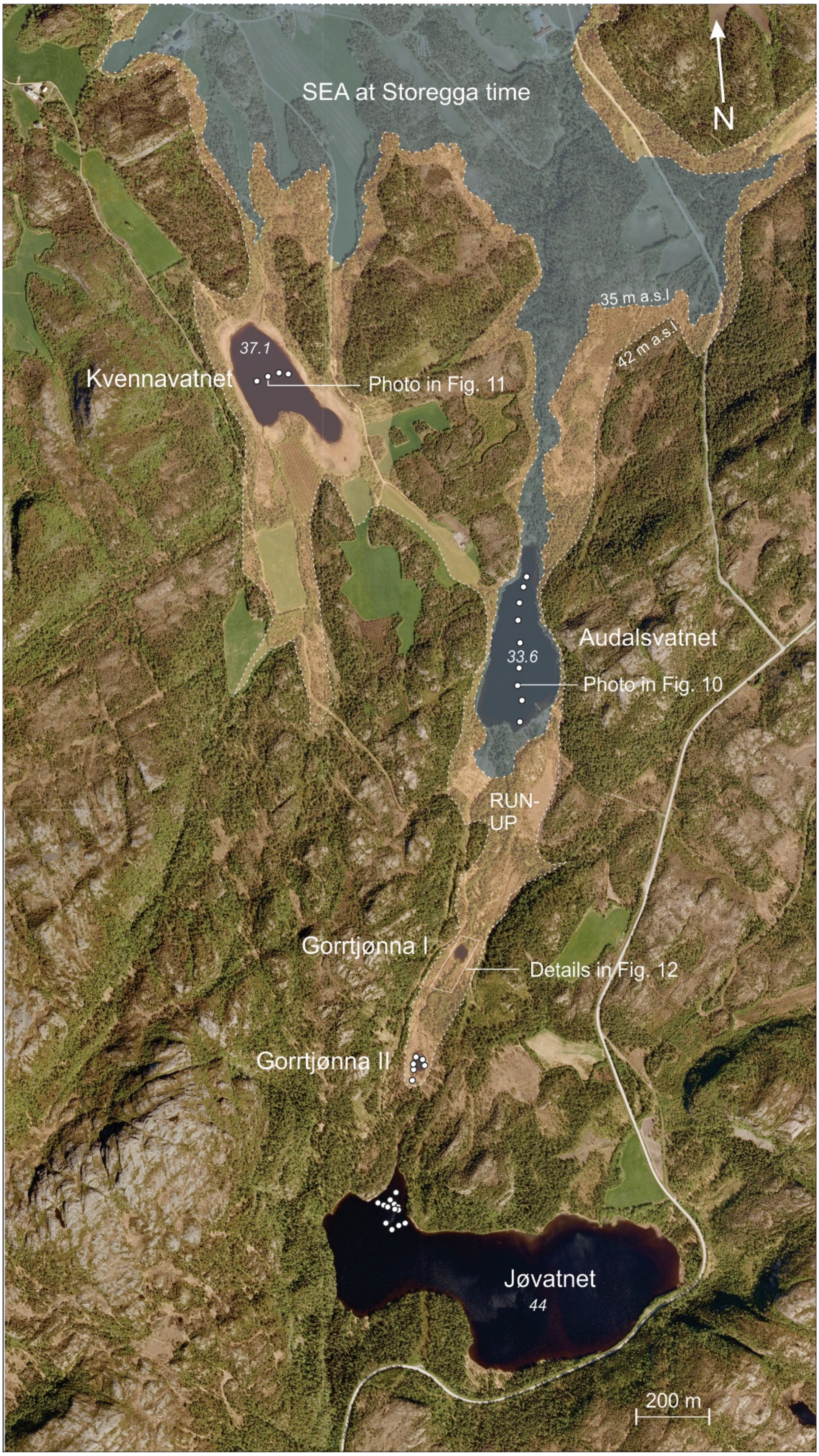

Fig. 9: Air photo of site e (Fig. 1, Table 1), Bjugn. Sea level at tsunami time in transparent blue – here shown as the surface below the 35 m-contour-line. Run-up is in transparent red – the surface between the 35 m contour line and up to ca. 42 m a.s.l. - drawn as a line between contour line 40 m and 45 m from 1:5000 maps. Cores as white dots. No tsunami deposits were found in Jøvatnet (44 m a.s.l). Audalsvatnet (33.6 m a.s.l.) was a few meters below sea level when the tsunami happened.

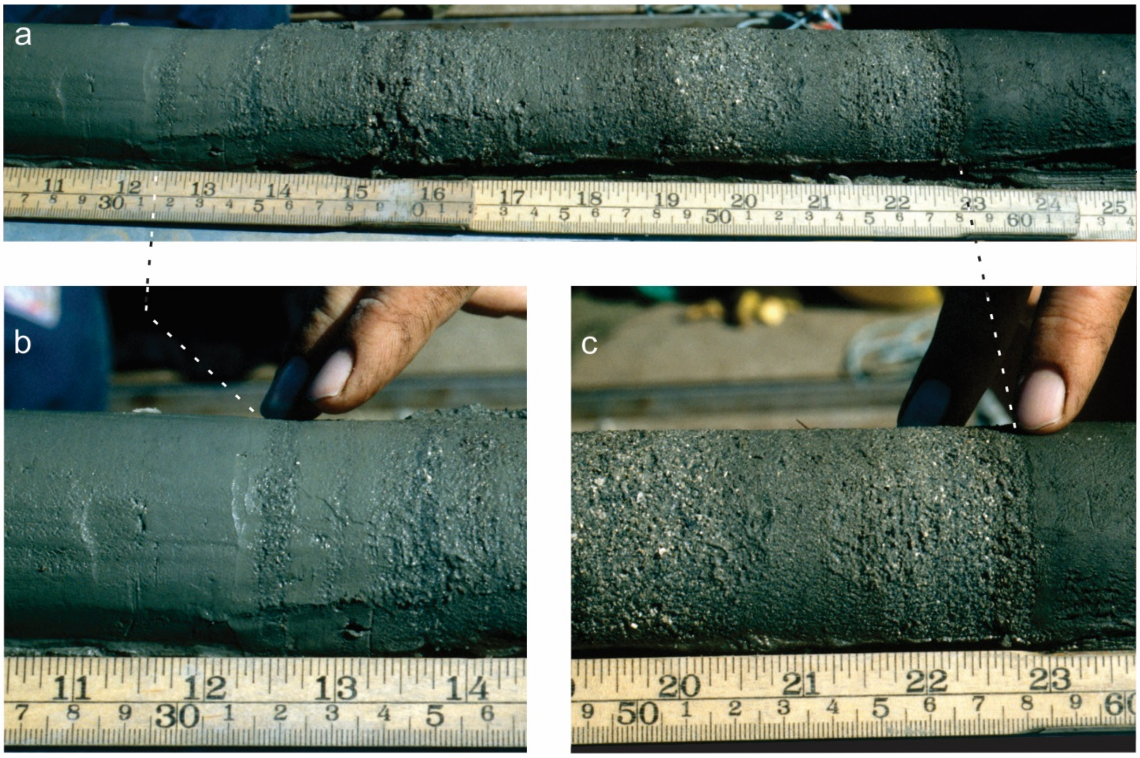

Fig. 10: **a** Photo of the Storegga deposits in Audalsvatnet, Bjugn (see location of core in Fig. 9). Ruler shows inches and cm. Below is a close-up of the upper boundary (**b**) and the lower boundary (**c**). The white spots in the sand are shell fragments. The four lowermost layers are graded sand, the other two sand layers above are massive sand separated by silt. Terrestrial moss stems were found in the sand layers – one was dated to 7315 ± 70 ^{14}C years BP (Bondevik et al., 1997a). The lower boundary is knife-sharp; the upper boundary is gradual, somewhere around 28 cm (12**28** cm below the lake surface) in grey silt.

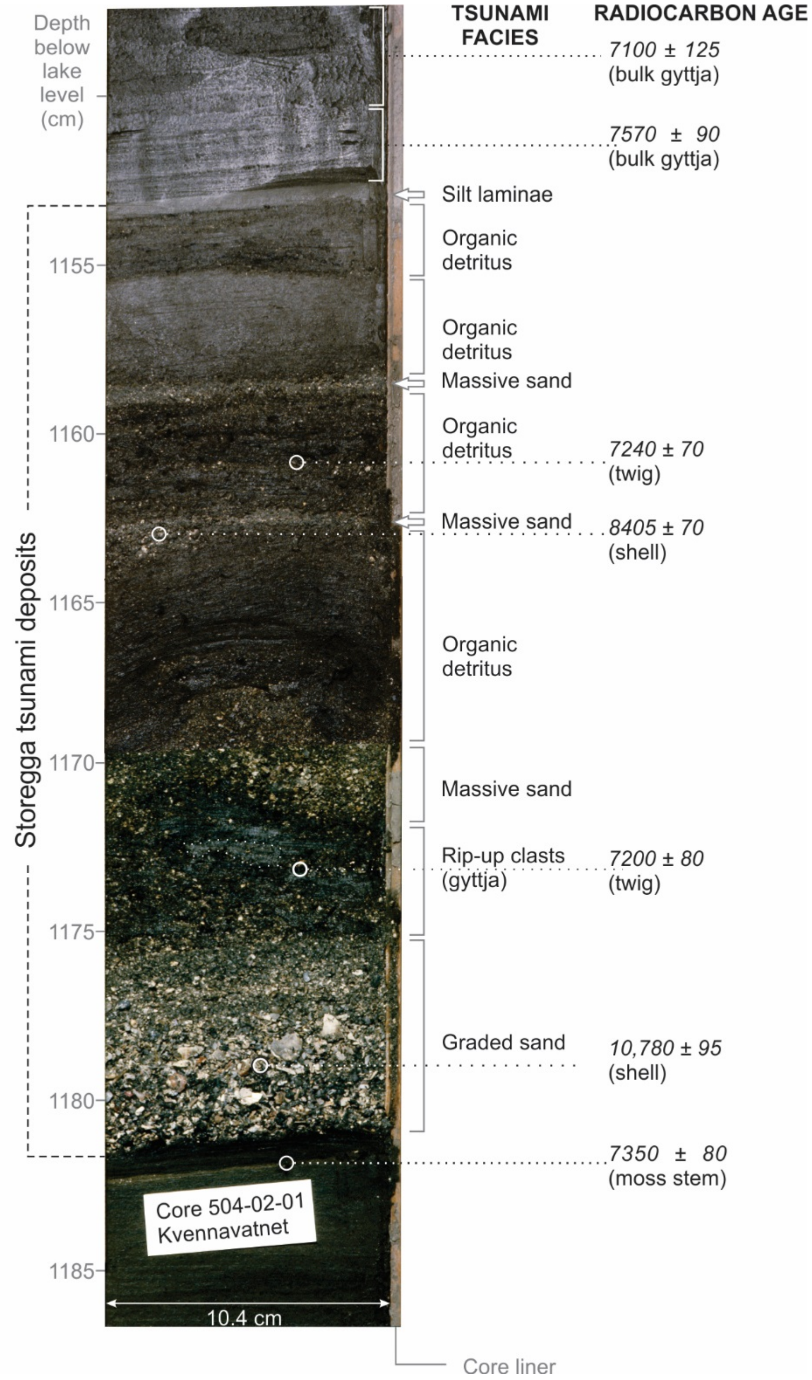

Fig. 11: Tsunami deposits in Kvennavatnet, Bjugn (see location of core in Fig. 9). Depth is cm below lake level. To the right is description of deposits and radiocarbon ages (in ^{14}C years BP).

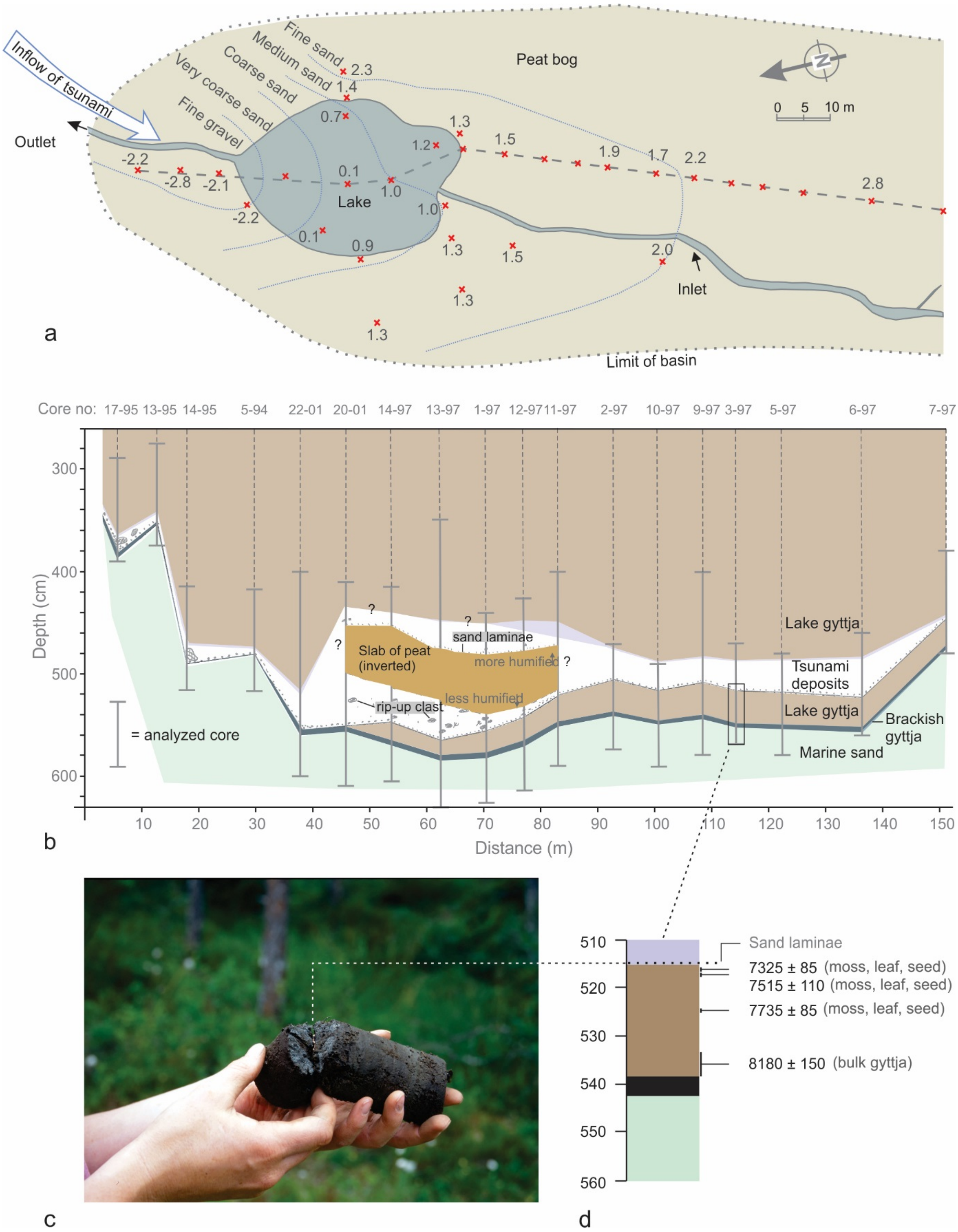

Fig. 12: Map, cross section, photograph and log from Gorrtjønna I, Bjugn (see location in Fig. 9; slightly modified from Fig. S3 in Bondevik et al., 2012). **a** Map with core locations (red crosses) and grain size in ϕ-units of tsunami-sand on the erosional boundary. **b** Cross section along the stippled line in **a**. Note the big slab of peat in the tsunami deposits. According to the cores the peat slab must be inverted (upside down) because it is more humified at the top than at the bottom. **c** Photo shows the sand lamina on the erosional boundary in core 3-97 – only a few sand grains thick. **d** Radiocarbon ages from core 3-97. The core was chosen for radiocarbon dating because of the little erosion underneath the tsunami deposits.

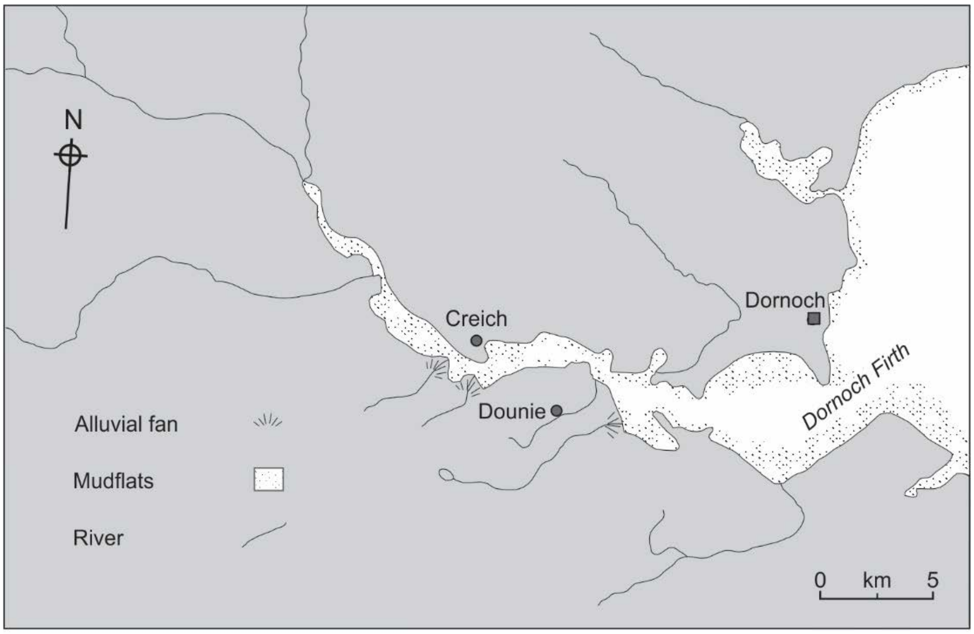

Fig. 13: Esuary at Dornoch Firth in eastern Scotland. Boreholes at Creich and Dounie (site q in Fig. 1 and Table 1) show Storegga tsunami deposits in estuarine mud, see profile from Creich in Fig. 14. [Redrawn from figure 1 in Smith et al. (1992)].

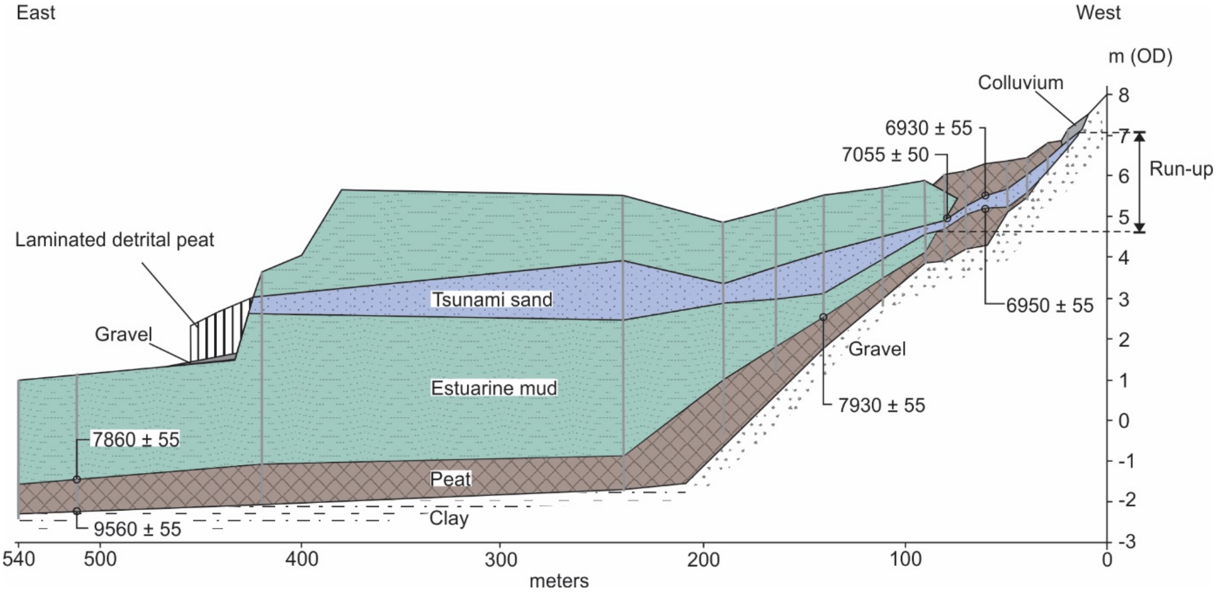

Fig. 14: Profile at Creich, cores in grey lines, ages in radiocarbon years. Run-up is measured from highest recorded surface of estuarine mud beneath the tsunami deposit and to the upper reach of the tsunami layer, here measured to 2.3 m. [Redrawn from Long et al. (1989) and Smith et al. (1992)].

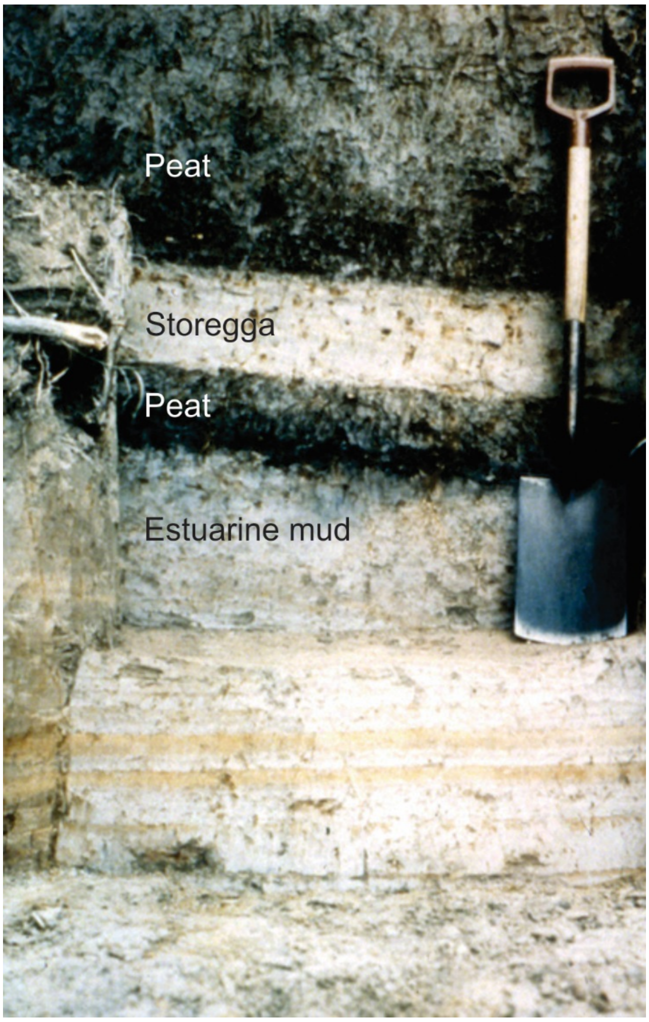

Fig. 15: Outcrop at Maryton in the Montrose basin (site t in Fig. 1 and Table 1) show the Storegga tsunami as a 25 cm thick silty sand deposit between peat. The estuarine mud is laminated silt and clay (photo David Smith).

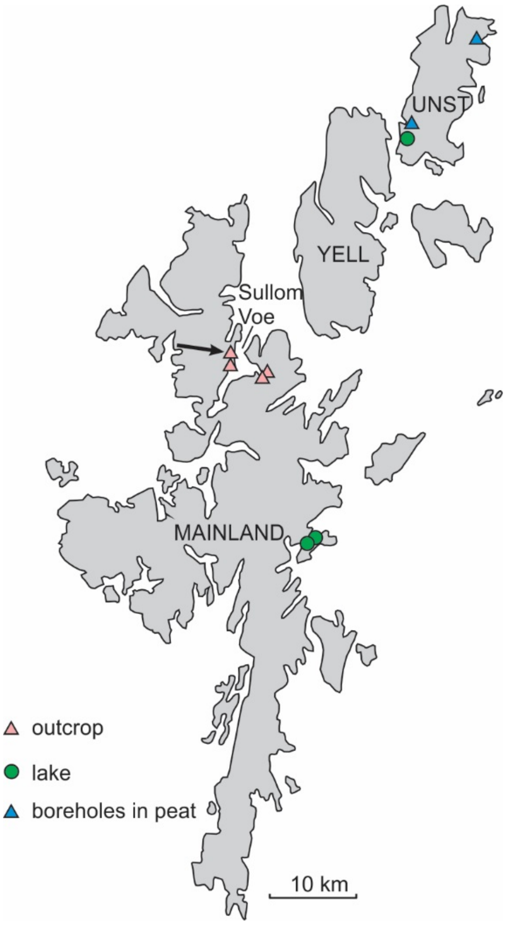

Fig. 16: Locations of Storegga tsunami deposits on the Shetland Islands. One of the outcrops, pointed to with an arrow, in Sullom Voe, is presented in more detail in text and in Figs. 17 and 18.

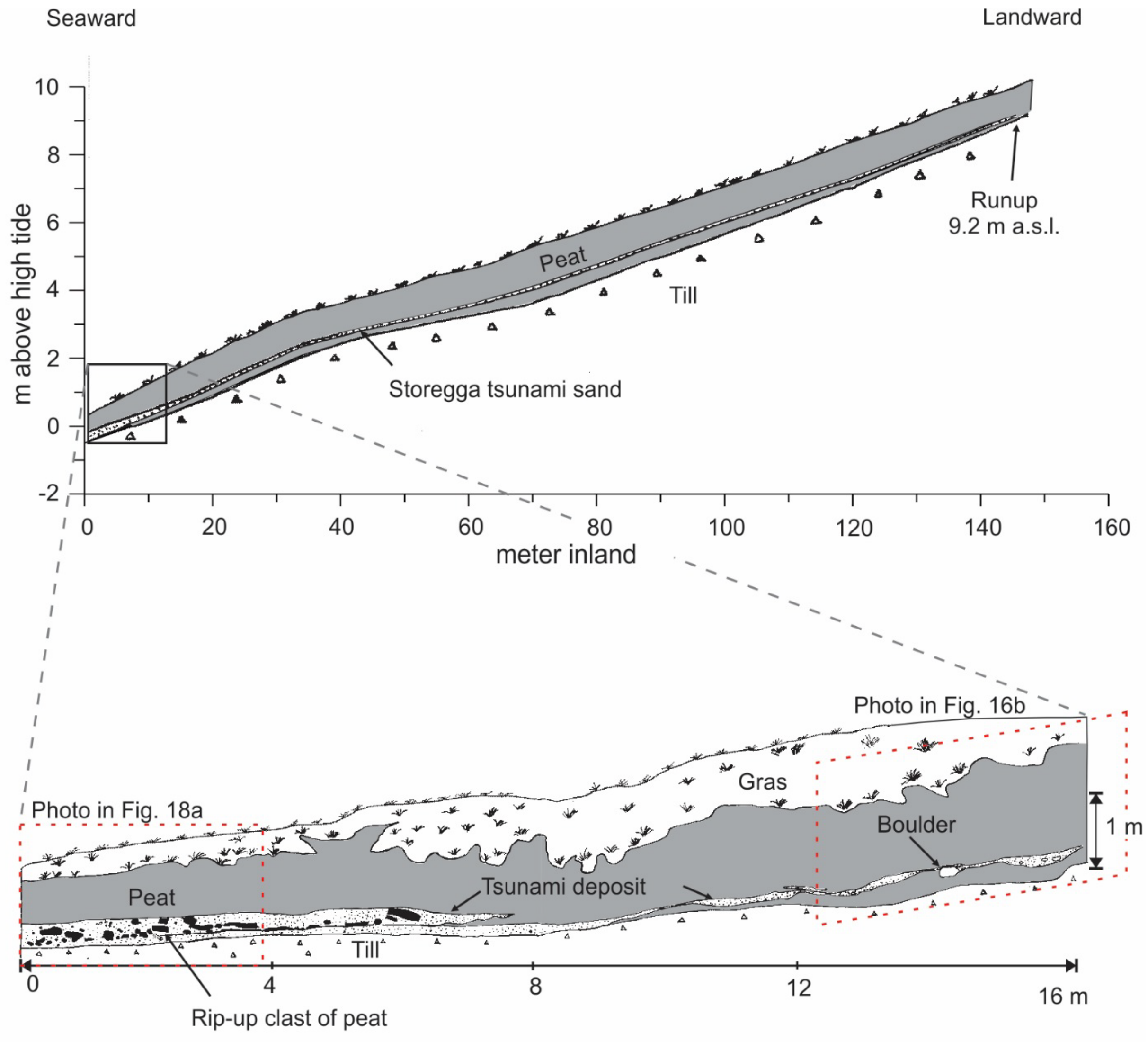

Fig. 17: The upper panel is a sketch of the Storegga tsunami layer in the 150-m-long peat outcrop on the western shore of Sullom Voe (Fig. 16) .The lower panel shows the first 16 m of the same outcrop. Between 0–6 m, large rip-up clasts of peat and pieces of wood embedded in the sand dominate the tsunami layer. Underneath the sand layer there is a profound erosional unconformity. Here the sand rests on till. From 9 m and inland, the sand is found in peat. Note that the sand layer thickens in the small depressions in the peat [redrawn from Fig. 2 in Bondevik et al. (2003)].

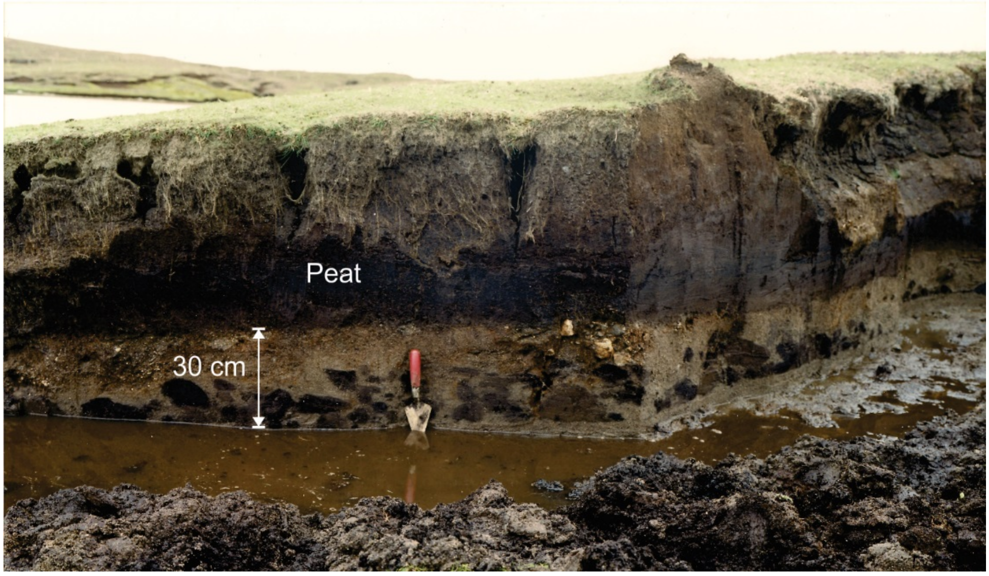

Fig. 18: **a** The first four meter of the outcrop (location indicated with a frame in Fig. 17) shows a large number of rip-up clasts embedded in the sand. Some of the clasts have sharp edges. The lower boundary of the peaty clasts forms a well-defined line in the sand. The red handle on the shovel is 9 cm long.

Fig. 18: **b** Photo showing the Storegga sand layer from about 12 m to 20 m in the peat outcrop (location indicated with a frame in Fig. 17). Note how the sand and gravel is thicker in the depressions in the peat. The shovel rests on hard till.

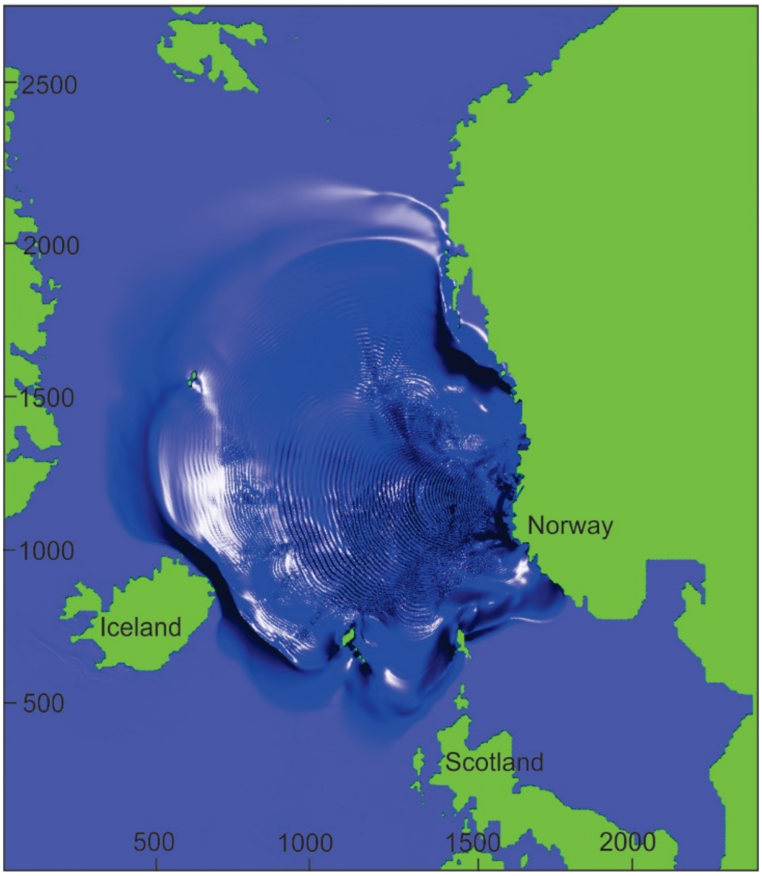

Fig. 19: Simulation of the Storegga tsunami 2 hours after the release of the slide. The wave front, ca. 3 m high, has just reached the Faeroe islands and Shetland. [Copy of fig. 8 in Bondevik et al. (2005a).]

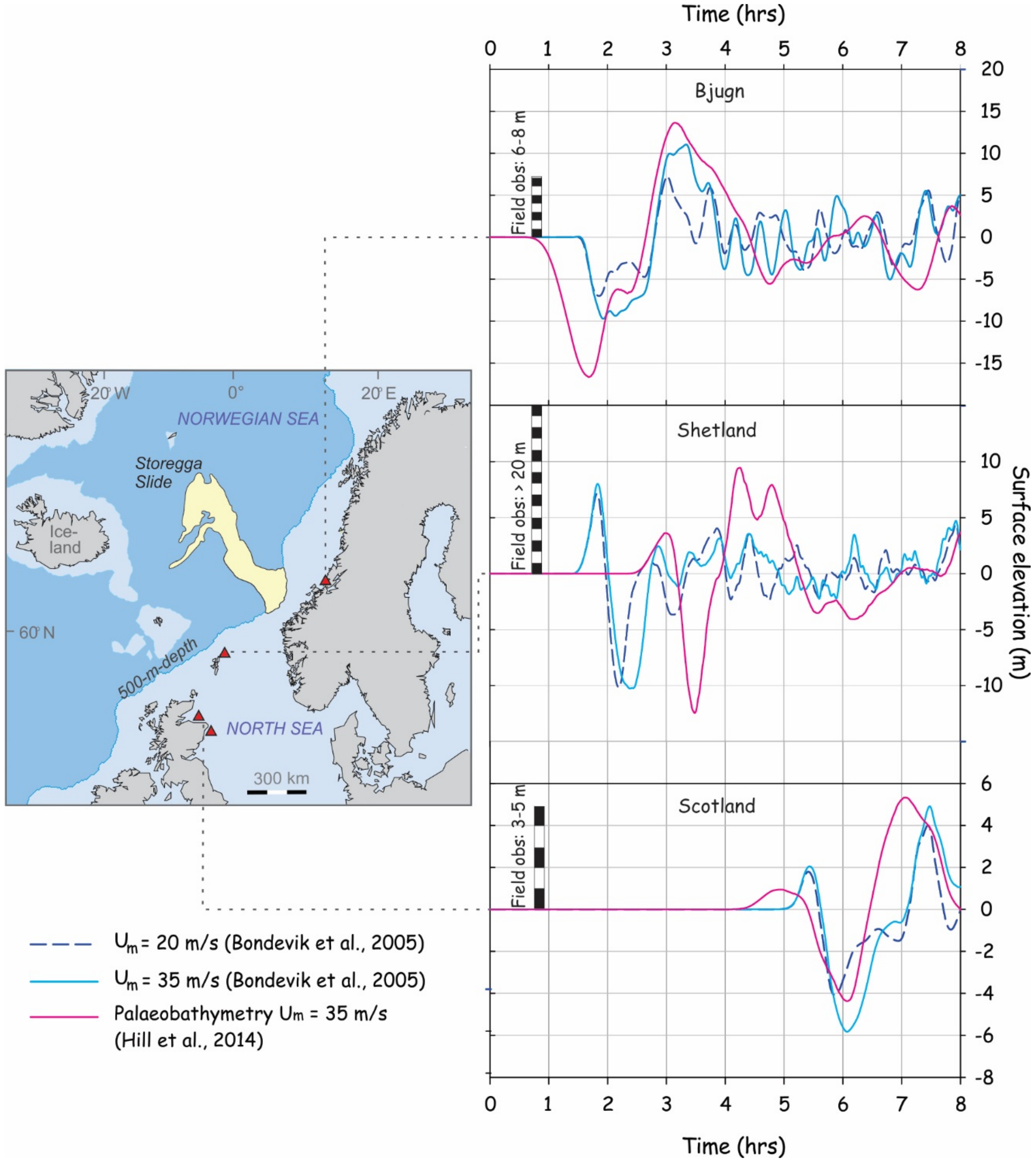

Fig. 20: Simulated sea surface elevation at Bjugn, Shetland and Scotland during the Storegga tsunami. The locations are identical for both simulations, except Scotland where Hill et al. (2014) has the northernmost location. The two simulations differ slightly in arrival time of the tsunami because they use different bathymetry. Hill et al. (2014) has better resolution of the bathymetry near the coastline and the bathymetry is also corrected for changes in sea level the last 8000 years.

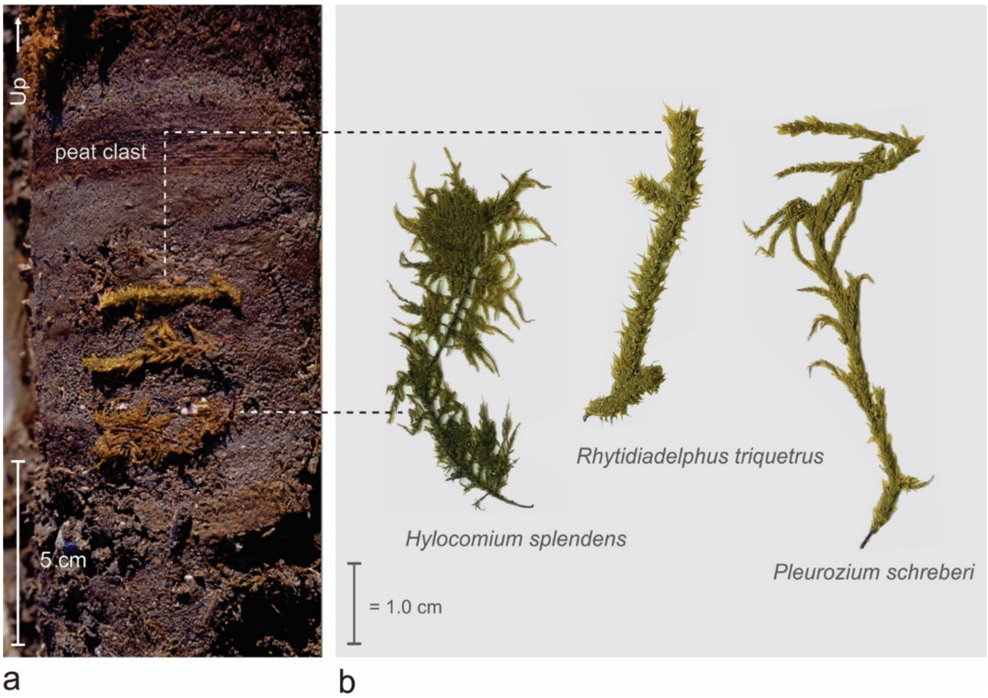

Fig. 21: Samples of green moss in Storegga tsunami deposits in Lyngen, Troms (site c, Fig. 1). To the left (**a**) is a photo of the core with tsunami backwash sediments. Terrestrial moss samples, washed out from a layer of shell fragments in the core, are placed clean on the core surface for display. The same moss samples to the right after being dried in the laboratory – the green color of the moss samples show much better off after drying.

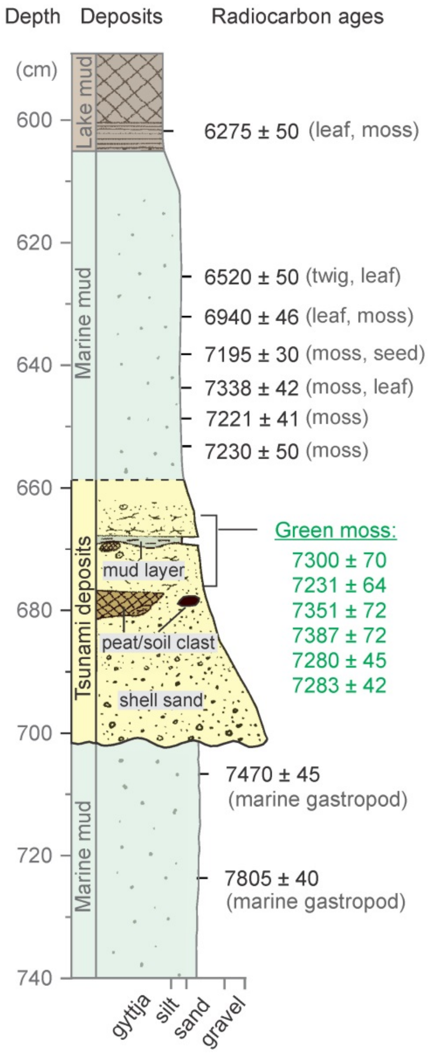

Fig. 22: Storegga tsunami deposits from core site 5 at Djupmyra in Hommelstø (site d in Fig. 1). Uncorrected radiocarbon ages to the left. Weighted average of the green moss dates is 7320 ± 20 ^{14}C yr BP, calibrated to 8070-8180 years BP (Bondevik et al., 2012). Note that the tsunami deposits contain backwash deposits of peat- and soil clasts and terrestrial plants, preserved beneath a cover of marine mud. [Copy of Figure 2 in Rydgren and Bondevik, 2015.]

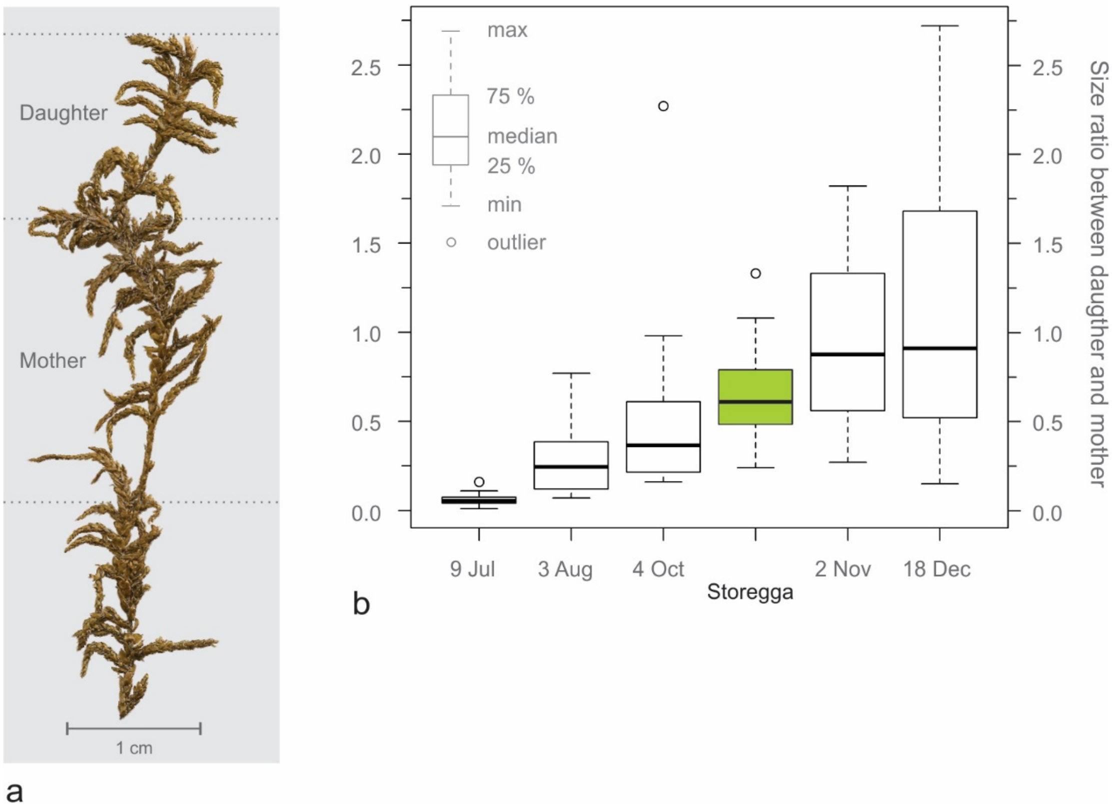

Fig. 23: **a** A well preserved sample of the moss *Hylocomium splendens* from Storegga tsunami deposits at Djupmyra, Hommelstø (Site d, Fig. 1, Fig. 22). The daughter segment is a little smaller than the mother segment. For this sample the daughter/mother size ratio is 0.63. **b** Plot of the size ratio between daughter and mother segments of *Hylocomium splendens* from modern samples (n = 20) collected in the months July, August, October, November and December. The size ratio of Storegga samples (n = 19) is somewhere between 4. October and 2. November. [From Fig. 4 in Rydgren & Bondevik, 2015.]