

Stop 20: Sutlema quarry

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Location: Latitude 59.17410°N, longitude 24.61958°E; Rapla County, central northern Estonia.
Stratigraphy: mid-Katian, Nabala and Vormsi regional stages, Saunja and Kõrgessaare formations.
Status: Active quarry, follow safety rules; sampling and fossil collecting welcome!
More information: <https://geoloogia.info/en/locality/16318>

The following text is based on Kröger and Toom (2023).

The Sutlema quarry is an active quarry c. 30 km south of Tallinn, west of Kohila, Rapla County. The quarry exposes the upper c. 7 m of the Nabala Regional Stage and c. 4 m of the overlying Vormsi Regional Stage, middle Katian (Fig. 20.1).

Stratigraphy

The boundary between the Nabala and Vormsi regional stages in northern Estonia is marked by a prominent discontinuity surface, interpreted as a paleo-karst horizon (Calner et al. 2010). The massive limestone underlying the discontinuity surface belongs to the Saunja Formation, and the relatively high $\delta^{13}C_{carb}$ values (up to 2.39 ‰, Meidla & Ainsaar 2014) are indicative of the Saunja Carbon Isotope Excursion (Baltic Chemostratigraphic Zone BC10, Ainsaar et al. 2010). The Saunja Excursion has been correlated with the middle Katian Waynesville Excursion in North America (Bergström et al. 2012; Meidla & Ainsaar 2014). The overlying strata of the Vormsi Regional Stage correspond to the middle Katian *Amorphognatus ordovicicus* Conodont Zone (Meidla et al. 2023).

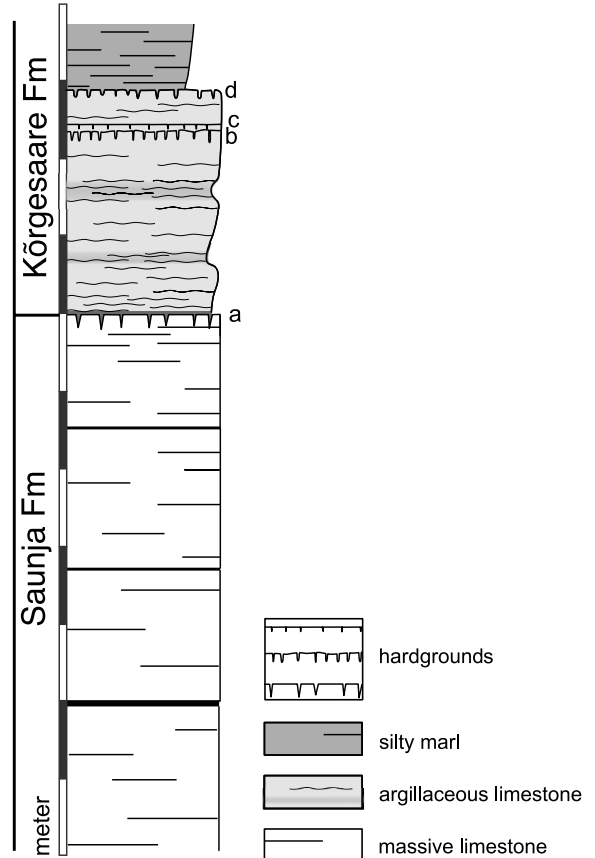


Fig. 20.1. Stratigraphy and lithology of the Sutlema quarry outcrop. Abbreviations: Fm, formation; a-d, denote individual hardground horizons.



Fig. 20.2. Overview of the Sutlema quarry, showing mining of the Saunja limestone (carbonate mudstone), Nabala Regional Stage, Mid-Katian. Photo: Olle Hints, 2022.

Sedimentology

Saunja Formation

The Saunja Formation at Sutlema consists of bedded (10–40 cm), fine-grained (lithographic), and bioturbated limestone with very thin (<1 cm) interlayers. Few interlayers with a thickness of more than one centimetre can be used to distinguish individual 1–2 m thick strata within the formation. Rhythmic bedding of argillaceous and carbonaceous beds is visible on fresh quarry walls (Fig. 20.3A, 20.4). Similar limestone and marl alternations are interpreted as resulting from diagenetic processes (Mun-

necke et al. 2023). The microfacies can be described as a lime-mudstone to skeletal grainstone with common echinoderm ossicles, microgastropods and fragments of bryozoans and skeletal green algae (Fig. 20.3). The lithology of the Saunja Formation has been described as Baltic limestone facies, in which calcitarchs are common (Kröger et al. 2019). At Sutlema, the abundant and well-preserved burrows of, e.g., *Chondrites*, *Phycodes* and *Planolites* are remarkable (Fig. 20.7C).

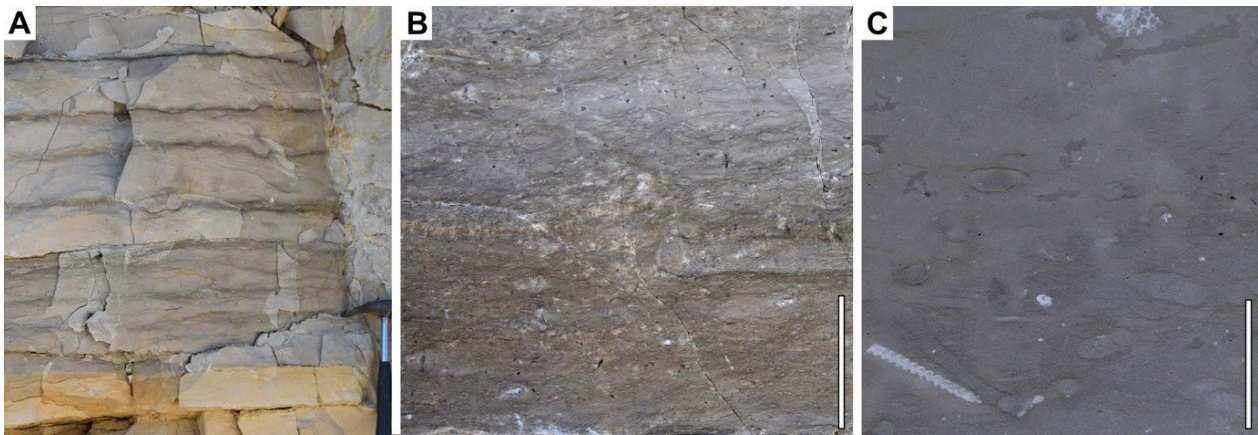


Fig. 20.3. Burrowed limestone of the Saunja Formation, Nabala Regional Stage, Katian, from the Sutlema quarry, Estonia. **A** – field perspective of a fresh outcrop; **B** – Detail of A, note the nested burrow pattern, scale 5 cm; **C** – thin section, with a fragment of brachiopod (lower left), *Coelospheridium* sp. (upper margin), and a micro-gastropod (center right), scale 5 mm.



Fig. 20.4. Limestone of the Saunja Formation, Nabala Regional Stage, Katian, from the Sutlema Quarry, Estonia. Photo: Olle Hints, 2020.

Kõrgessaare Formation

The Kõrgessaare Formation at Sutlema consists of a grey to greenish coloured, wavy bedded to nodular limestone-marl alternation of argillaceous skeletal wackestone (Figs 20.5, 20.6) and marl. The base of the formation is a flat discontinuity surface formed by a hardground on the top of the Saunja Formation. This hardground is heavily burrowed and bored by *Balano-*

glossites and *Trypanites* trace-makers and shows signs of karstification (Fig. 20.7B). The burrows reach down to 7 cm into the Saunja Formation and are partly filled with argillaceous wackestone of the Kõrgessaare Formation. The exposed part of the Kõrgessaare Formation consists of a thickening-up sequence with a series of prominent hardgrounds at its top (levels b, c, d in Fig. 20.1). The

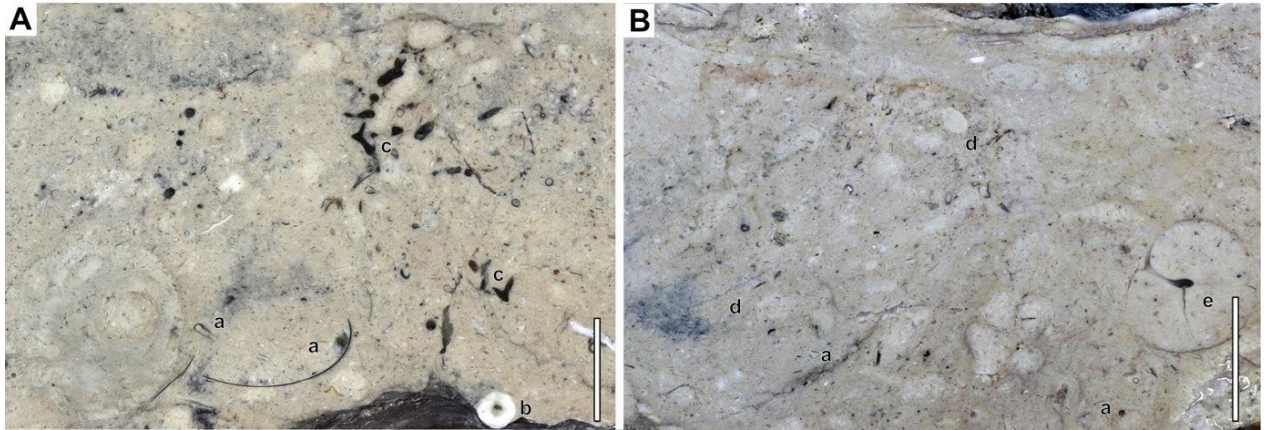


Fig. 20.5. Polished cross section of a burrowed skeletal wackestone from c. 1 m above base of the Kõrgessaare Formation, Vormsi Regional Stage, Katian, from the Sutlema quarry, Estonia. **A** – Detail with abundant trilobite carapace fragments (a), echinoderm ossicle (b) and a hydroid? Colony (c); **B** – Detail with abundant trilobite carapace fragments, bryozoan colony (d) and gastropod (e). Scale bars correspond to 1 cm.



Fig. 20.6. Limestone of the Kõrgessaare Formation, Vormsi Regional Stage, Katian, from the Sutlema Quarry, Estonia. Photo: Gennadi Baranov, 2021.



Fig. 20.7. Selected fossils from the Sutlema quarry, Kõrgessaare and Saunja formations (Katian). Scale bars: A – 50 cm, B, C, H, J, K – 1 cm; E – 5 mm; F, D, G, I – 1 mm. **A** – large borings of *Thalassinoides suevicus* from the Kõrgessaare Formation, field image. **B** – bored, bioeroded and karstified hardground on the top of the Saunja Formation, GIT 881-9. **C** – abundant trace fossil *Chondrites intricatus* on the bedding plane, Saunja Formation, GIT 362-912. **D** – clusters of small faecal pellets of *Coprulus oblongus* filling gastropod, Saunja Formation, GIT 404-686-1. **E** – bioerosional trace fossil *Trypanites sozialis* on hardground, Kõrgessaare Formation, GIT 362-865-2. **F** – algal bioerosional traces, hardground on the top of the Saunja Formation, GIT 881-27-3. **G** – bryozoa *Corynotrypa delicatula* encrusting large brachiopod *Porambonites*, Kõrgessaare Formation, GIT 812-74-1. **H** – bioerosional trace fossil *Trypanites weisei*, hardground on the top of the Saunja Formation, GIT 881-28. **I** – bryozoan holdfast encrusting hardground on the top of the Saunja Formation, GIT 881-26-2. **J, K** – tabulate corals from the Kõrgessaare Formation; **J** – *Sarcinula*, GIT 649-9; **K** – *Catenipora*, GIT 734-78.

double hardground (levels b and c) is also heavily burrowed, bored, and probably karstified. The uppermost hardground of this sequence (level d) is rough and weakly bored; it is impregnated with phosphatic minerals and

partly stained with glauconite. Above this hardground a c. 1 m thick wavy bedded, silty, grey marly layer occurs, rich in rhynchonelliform brachiopods.

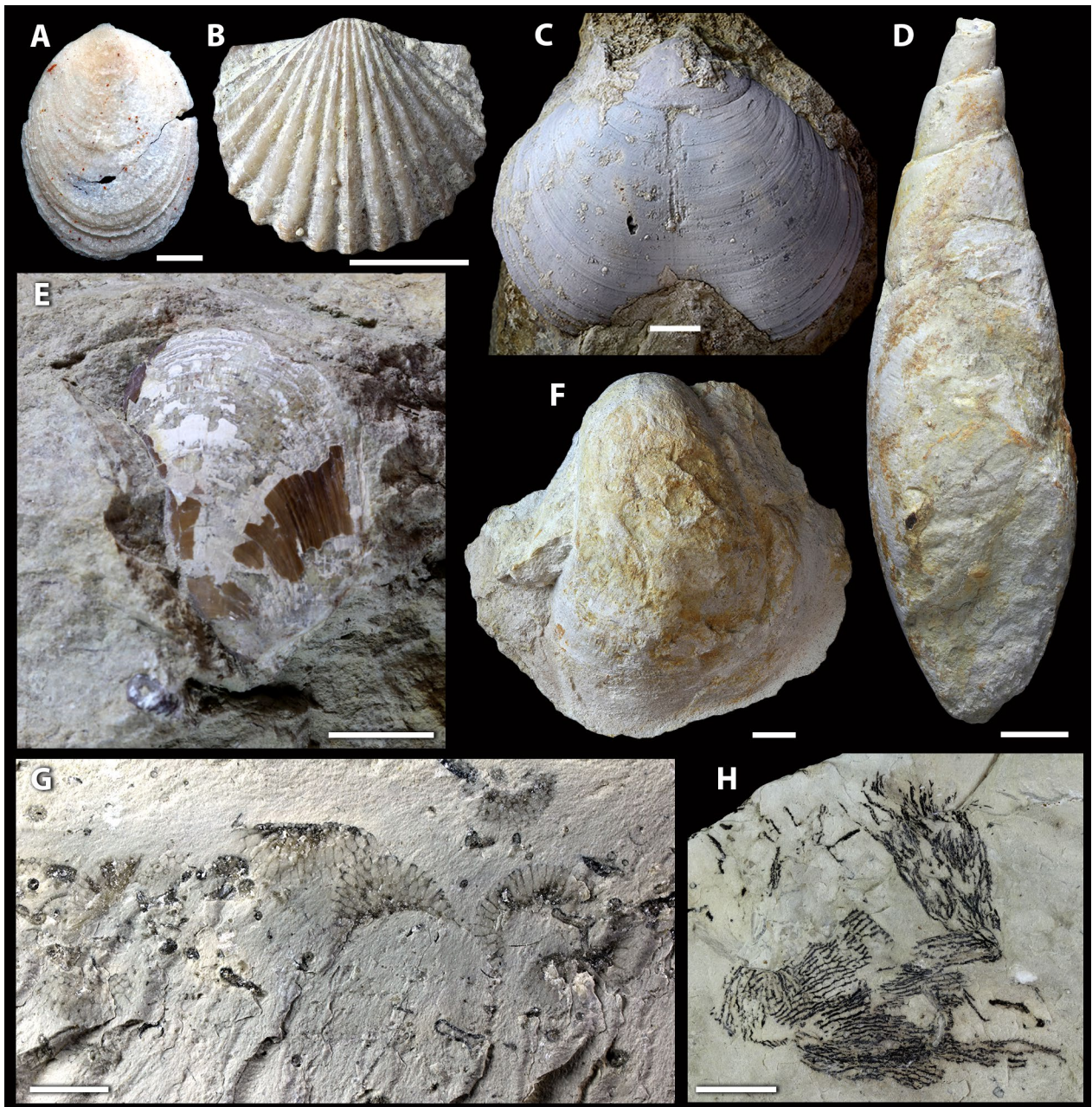


Fig. 20.8. Selected fossils from the Sutlema quarry, Kõrgessaare and Saunja formations (Katian). Scale bars: C–H – 1cm, B – 5 mm, A – 0.5 mm. **A–C, E** – brachiopods from the Kõrgessaare Formation; **A** – *Pseudopholidops*, GIT 737-254; **B** – *Sulevorthis lyckholmiensis*, GIT 673-488; **C** – *Porambonites gigas*, GIT 673-489; **E** – *Pseudolingula quadrata* in the life position, GIT 810-177. **D–F** – gastropods from the Kõrgessaare Formation; **D** – *Subulites subula*, GIT 812-114; **F** – *Salpingostoma kokeni*, GIT 812-100. **G** – algae *Vermiporella* and *Coelosphaeridium* from the Saunja Formation, GIT 812-54. **H** – dendroid *Dictyonema* from the Saunja Formation, GIT 812-1-2.

Fauna and Flora

Fossils are relatively rare but highly diverse in the Saunja Formation. A rich flora of calcareous skeletal algae occurs (e.g., a form provisionally assigned to *Coelosphaeridium*, the green algae *Vermiporella*, and the receptaculite *Tetragonis sulcata* (Fig. 20.9C). Poriferans are abundant. Molluscs are relatively well preserved with gastropods (e.g., *Murchisonia*, *Subulites*), cephalopods (e.g., *Striatocycloceras*), and bivalves present. Well-preserved dendroid graptolites, tentaculids such as *Palaenigma wrangeli* and enigmatic carbonaceous remains of colonial organisms, here tentatively identified as hydroids (Fig. 20.9A) are remarkable.

Fossils are abundant in the Kõrgessaare Formation. Large gastropods are common (e.g., *Hormotoma*, *Fusispira*, *Megalompha*, *Subulites*, *Salpingostoma*, *Sinuities*). They are most abundant in the layer c. 10 cm above the base of the formation. Cephalopod occurrences include endocerids and the orthocerid *Striatocycloceras*. From the marly horizons within the Kõrgessaare Formation, a rich fauna of cornulitids has been described (Vinn et al. 2022). Coral occurrences include tabulates (e.g., *Catenipora*, *Heliolites*, *Protaraea*, *Propora*, *Sarcinula*) and rugosans (Fig. 20.7). Small craniid *Pseudopholidops* and the large lingulid *Pseudolingula quadrata*, which occurs

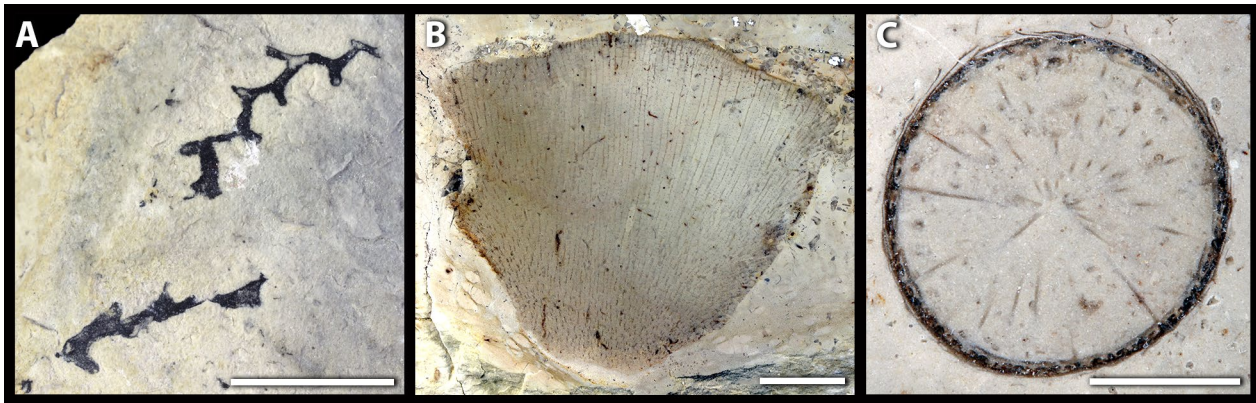


Fig. 20.9. Selected fossils from the Sutlema quarry. Saunja Formation (Katian). Scale bars: A, B – 1 cm; C – 5 mm. **A** – remains of colonial organisms, tentatively determined as hydroids, GIT 812-39. **B** – anthaspidellid sponge, GIT 812-24. **C** – retceptaculid *Tetragonis sulcata*, GIT 812-23.

in life position (Fig. 20.8E), are common. Rhynchonelliformeans collected from the Kõrgessaare Formation in the Sutlema quarry include, e.g., *Bekkeromena*, *Boreadorthis recula*, *Glyptorthis*, *Kiaeromena* (*Bekkeromena*) *vormsina*, *Neoplatystrophia*, *Nicollela*, *Plaesiomyx saxbyana*, *Porambonites gigas*, *Sampo hiiuensis*, *Sulevorthis lyckholmiensis*, *Triplesia* and *Vellamo verneuilii*. Several shelly fossils are encrusted by bryozoans of *Corynotrypa delicatula* (Fig. 20.7G).

The epizoans of the hardgrounds include cornulitids, crinoids, bryozoans, brachiopods, and tabulate corals. The bioerosional ichnofauna of the hardgrounds is abundant, consisting of the shallow-marine firmground trace fossil *Balanoglossites triadicus*. The hard-substrate

boring *Trypanites* and algal bioerosional traces are most common (Fig. 20.7E, F, H). The ichnogenus *Trypanites* is represented by three species, shallow *T. socialis*, elongated *T. weisei*, and course-changing *Trypanites* isp.

The degree of bioturbation of the Kõrgessaare Formation is high, with a characteristic branching burrow system of *Thalassinoides*. Gastropods of the Saunja and Kõrgessaare formations are frequently filled with small faecal pellets. They occur as massive clusters of ichnospecies *Coprulus oblongus* and more rarely represent the ichnogenus *Tubularina* (i.e., burrows filled with sparry calcite and coprolites). Ichnogenera recorded from steinkerns of gastropods are *Pilichnus* and *Palaeophycus*.

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