

ISOS-14 Field Guide

The Ordovician of Estonia

Edited by Olle Hints and Ursula Toom

14th International Symposium on the Ordovician System, Estonia, July 19-21, 2023

Pre-conference Field Excursion: The Ordovician of Estonia, July 15-18, 2023



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Stop 11: Aru-Lõuna (Kunda-Aru) quarry

Leho Ainsaar

Location: Latitude 59.44406°N, longitude 26.47941°E; Lääne-Viru County, NE Estonia.

Stratigraphy: Darriwilian, Kunda to Uhaku regional stages.

Status: Active quarry; please follow safety instructions. Hammering and fossil collecting are welcome!

More information: <https://geoloogia.info/en/locality/10007>

The large, ca 3.5 km² in area, active Aru-Lõuna (Aru-South) limestone quarry is located south of the small town of Kunda and is operated by the company Heidelberg Materials Kunda AS. The limestone is used for the manufacture of cement and crushed limestone aggregate. Cement production in Kunda has a 130-year history.

The Aru-Lõuna quarry walls expose an excellent over 18 m thick succession of Middle Ordovician carbonates (Fig. 11.1, 11.4). The lower part of the Darriwilian Stage (Kunda and Aseri regional stages) is exposed by the smaller escarpments (ca 3 m) on the quarry floor (stop A; Fig. 11.2) or trenches. The main wall section (stop B; Fig. 11.3) spans the succession of the middle to the upper part of the Lasnamägi and lower to the middle part of the Uhaku regional stages, being coeval with the upper part of the Darriwilian Stage.

The boundary between the Kunda and Aseri regional stages is marked by a pyritised discontinuity surface with deep (8–15 cm) burrows (pockets; Einasto & Hints 2004). It is underlain by thick-bedded skeletal fine-detrital packstone with small glauconite grains of the Loobu Formation. The Kandle Formation of the Aseri Regional Stage is represented by oolitic limestone, medium-bedded brownish-grey skeletal packstone to grainstone with some sharp goethitic discontinuity surfaces. The thickness of the Kandle Formation is 1.3–1.5 m. The Aseri Stage represents the peak of the Middle Darriwilian Carbon Isotope Excursion on the $\delta^{13}\text{C}$ curves. It has been recognised in the Kandle Formation of the Aru-Lõuna quarry section, reaching the $\delta^{13}\text{C}$ of +1‰ on a back-

ground of +0.3‰ (Ainsaar et al. 2020).

Two main limestone units, the Vão and Kõrgekallas formations, are exposed in the southeastern quarry wall. The lower unit, Vão Formation (Lasnamägi and lower Uhaku regional stages), represents the main building limestone in the coastal areas in northern Estonia, including Tallinn. It is composed of light grey wackestone-packstone with a large number of distinct discontinuity surfaces and burrows. Thin interbeds (0.2–4 cm) of wavy microlaminated marlstone intercalate with limestone beds of 10–30 cm in thickness. The reddish-brown pattern of burrows is a characteristic feature of the Lasnamägi building stone. The total thickness of the Vão Formation is about 11 m, and it is subdivided into the Rebala, Pae, and Kostivere members.

The upper unit, Kõrgekallas Formation, is represented by wavy-bedded to seminodular argillaceous limestone (wackestone) with interbeds (8–20 cm) of pure skeletal packstone. The total thickness of the formation is about 10 m. The lowermost and middle members of the formation, the Koljala and Pärtliorg members, are exposed in the upper part of the main quarry wall and on the uppermost terrace in a thickness of 7 m.

For centuries, the Lasnamägi building limestone was quarried manually and used widely in the Tallinn area. Except for the formal lithostratigraphic units, the individual limestone beds have been referred to by names and numbers introduced during the long tradition of quarrying. In total, 70 individual limestone beds have been distinguished in the Vão and Kõrgekallas formations, each



Fig. 11.1. Overview of the Aru-Lõuna quarry. Photo: Leho Ainsaar, 2023.

represented by a sedimentary cycle of marlstone-limestone (Einasto & Hints 2004). Considering the deposi-

tional time for the whole interval ca 2.5–3 myr (Goldman et al. 2020) it gives an average time for the cycle 36–42 kyr, fitting well with the Milankovitch 41K obliquity cyclicality.

The Aru-Lõuna quarry is rich in fossils, especially in the lower part of the succession (Fig. 11.5).

Description of the outcrop (modified from Einasto and Hints 2004)

Lasnamägi–Uhaku stages, Vão Formation

(a) The Rebala Member forms the lower part of the Vão Formation. The lowermost Rebala Member (2.8 m thick) is represented by thin-to thick-bedded argillaceous limestone, very seldom used as building stone. The thick-bedded lower part (0.75 m) is considered a good building stone, but excavating it below the argillaceous limestones is complicated. In the quarry, the Rebala Member is exposed only partly.

(b) The Pae Member is 0.8 m thick in the Aru quarry. The rocks of this member are commonly secondarily dolomitised and well visible as a more brownish belt in the sections. The dolomitisation is very weakly developed, and the member does not differentiate very clearly in the quarry walls. The Pae Member consists of medium- to thick-bedded, slightly argillaceous limestone with interbeds of calcareous marlstone (up to 10 cm thick in the upper part).

(c) The Kostivere Member, 7.5 m in thickness, is represented by light grey thick- to medium-bedded pure skeletal packstone with numerous distinct discontinuity surfaces, interbeds of marlstone, and some interbed of skeletal packstone marks the basal part of microcyclites. The member represents the best quality building stone in northern Estonia. By the bed-by-bed correlation of the stratotype Lasnamägi and Kunda sections using the distinctive beds named given by quarry workers, the boundary between the Lasnamägi and Uhaku stages is situated about 1.2 m higher from the base of the Kostivere Member.

Uhaku Stage, Kõrgekallas Formation

(a) The Koljala Member is 2.7 m thick and consists of relatively pure skeletal packstone and argillaceous limestone (wackestone) with marlstone interlayers. On the upper surfaces of less argillaceous limestone, there occur discontinuities with pockets, similar to those in the Lasnamägi Stage. They mark the boundaries of microcyclites. The kukersite kerogene grains appear in the marlstone interlayer in the upper part of the member (0.85 m). The upper bound-



Fig. 11.2. Stop A in the Aru-Lõuna quarry. Photo: Leho Ainsaar, 2023.



Fig. 11.3. Stop B in the Aru-Lõuna quarry. Photo: Leho Ainsaar, 2023.

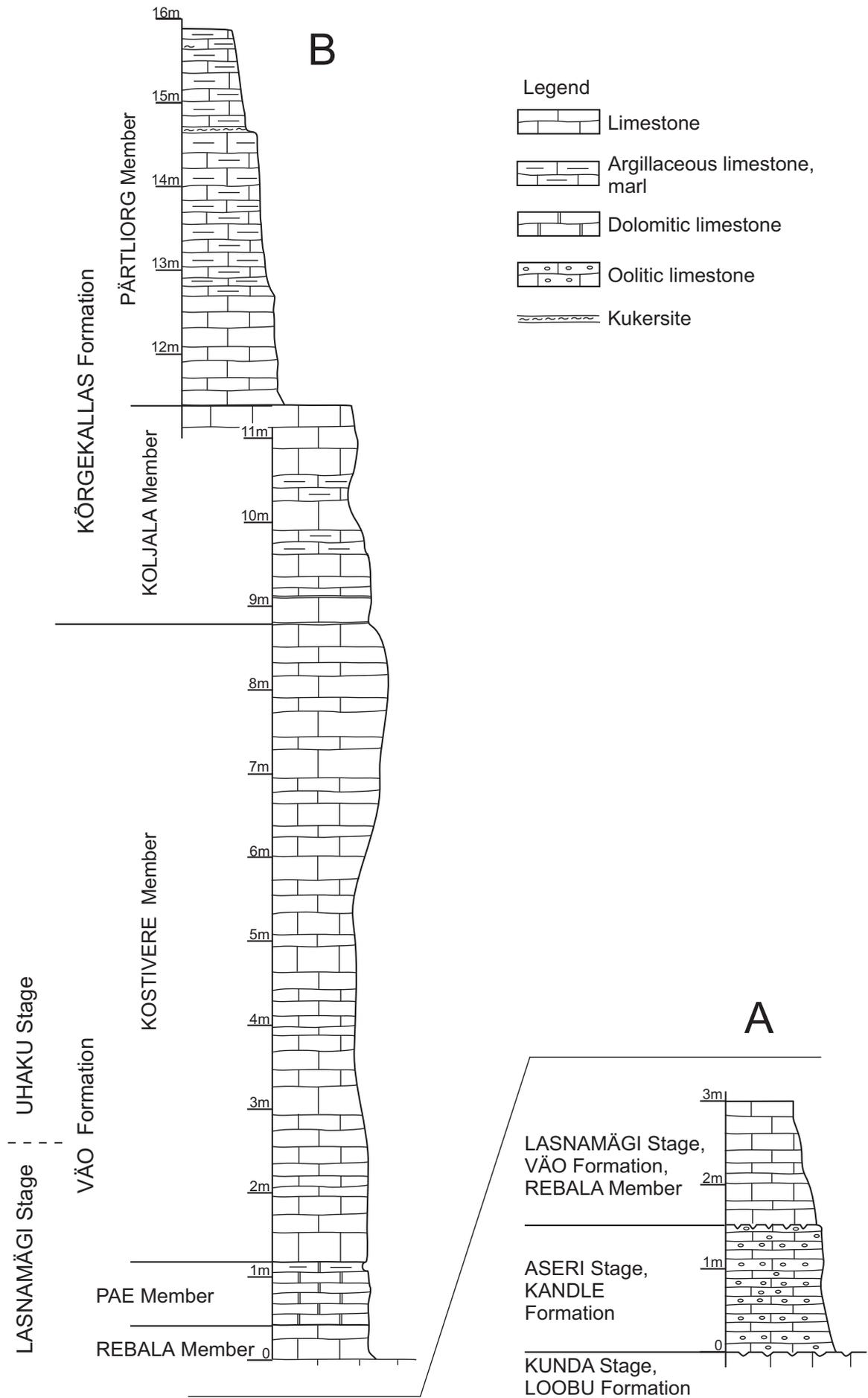


Fig. 11.4. Aru-Lõuna succession.



Fig. 11.5. Selected Darriwilian fossils from the Kunda-Aru quarry. Scale bars: M – 5 cm; A–F, H–J – 1 cm; G, K, L – 5 mm. **A–B** – blastozoans from the Kõrgekallas Formation; **A** – *Sphaeronites*, GIT 337-470; **B** – *Echinospaerites aurantium*, GIT 398-348; **C** – *Heliocrinites*, GIT 398-357. **D** – graptolite *Hormograptus sphaericola*, attached to the cystoid *Echinospaerites aurantium*, GIT 602-21. **E–F** – trilobites; **E** – *Paraceraurus*, Vão Formation, GIT 337-365; **F** – *Illaenus*, Kunda Regional Stage, GIT 437-73. **G–H** – brachiopods from the Kõrgekallas Formation; **G** – *Tallinnites imbrexioidea*, GIT 337-978; **H** – *Porambonites (Equirostra) aequirostris*, GIT 337-1303. **I, M** – cephalopods; **I** – *Lituites lituus?*, Vão Formation, GIT 337-366; **M** – fragment of large *Endoceras incognitum*, Kunda Regional Stage, GIT 225-1030. **J, K** – gastropods from the Kunda Regional Stage; **J** – trace fossil *Arachnostega gastrochaenae* on the gastropod *Lesueurilla helix steinkern*; **K** – *Pararaphistoma qualteriata*, GIT 337-960. **L** – bryozoan *Orbipora distincta*, Kõrgekallas Formation, GIT 337-1304.

ary is marked by the last distinct discontinuity surface with burrows (pockets).

(b) The Pärtliorg Member is exposed in thickness of 4.5

m, consisting of semi-nodular argillaceous wackestone with rare pure limestone (packstone) and marlstone interbeds with occasional kukersite enrichment and a 10 cm thick kukersite bed in the uppermost part.

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