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The Archaean-Paleoproterozoic transition: First results of detrital zircon U-Pb-geochronology and provenance from the FAR DEEP drill cores

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The Archaean-Paleoproterozoic transition is marked by several events that were important for the evolution of the Earth system. We applied U-Pb-geochronology on detrital zircons by LA-ICP-MS to improve age constraints on the duration of three of these events: 1) the Huronian Glaciation, which is the first known worldwide glaciation, 2) the Lomagundi-Jatuli event, characterized by a large excursion of δ^{13}C in carbonate sediments and 3) the Shunga event, the first deposition of very C_{org}-rich sediments, so-called "shungites". During the Fennoscandian Arctic Russia - Drilling Early Earth Project (FAR DEEP), which is part of the International Continental Scientific Drilling Program (ICDP), volcano-sedimentary successions of early Paleoproterozoic age were drilled in the Pechenga and Imandra-Varzuga Greenstone belts, as well as in the Onega basin in Russian Fennoscandia.

The first results of detrital zircon dating provided an age range from 1.85 up to 3.5 Ga having one prominent age-group of 2.5-2.9 Ga for each sample. The youngest ages in individual samples vary due to their stratigraphic position. The youngest zircons from the Seidorechka Sedimentary Formation below Huronian glacial deposits in the Imandra-Varzuga Greenstone Belt yielded ages around 2.42 Ga, which are interpreted as the age close to the onset of the Huronian Glaciation. Zircon ages from the Polisarka Sedimentary Formation above Huronian diamictites in the Imandra-Varzuga Greenstone Belt indicate that the glaciation had ended at 2.22 Ga. The youngest zircon ages from the sequence containing isotopically heavy carbonates of the Kuetsjärvi Sedimentary Formation in the Pechenga Greenstone Belt suggest that the Lomagundi-Jatuli event started around 2.32 Ga and that its end is younger than 2.06 Ga. Age constraints of ca. 2.0-1.9 Ga for the beginning of the Shunga Event were obtained by dating zircons from the Kolasjoki Sedimentary Formation in the Pechenga Greenstone Belt. Considering the error, these zircon ages confine the transition from the Lomagundi-Jatuli event to the Shunga event at 2.06-2.0 Ga. These first results provide independent evidence in support of previous age indications for these events.

Another aim of the study is to investigate provenance and source areas of the analysed detrital zircons. The largest age group around 2.9-2.5 Ga points to orogenic processes during the formation of the Fennoscandian Shield. Collisional and accretional processes during the Saamian (3.1-2.9 Ga) and Lopian orogeny (2.9-2.6 Ga) recycled detritus from surrounding Archaean granitoid sources into the study area. Ages around 2.4 Ga indicate maximum depositional ages for the Seidorechka Sedimentary Formation. At this time, earliest Paleoproterozoic magmatism occurred which might have produced source rocks for stratigraphically younger sedimentary successions like the Polisarka, Neverskrukk and Kuetsjärvi Formations. In combination, zircon ages of 2.6-2.1 Ga from these formations may be linked to active plate-margin complexes, accreted to Fennoscandia, which also includes mafic plateau volcanicsm, intracratonic sedimentation and continental rift systems. Furthermore, break-up of the shield followed by drifting was underway at 2.2-1.95 Ga. Zircon grains having ages of 2.1-1.9 Ga derived from sources connected to the Svecofennian orogeny.