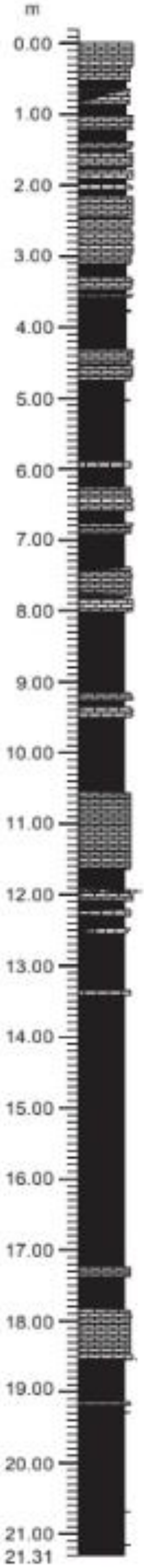

The content, chemical state and accumulation of vanadium in a drill core of Alum shale from Kinnekulle

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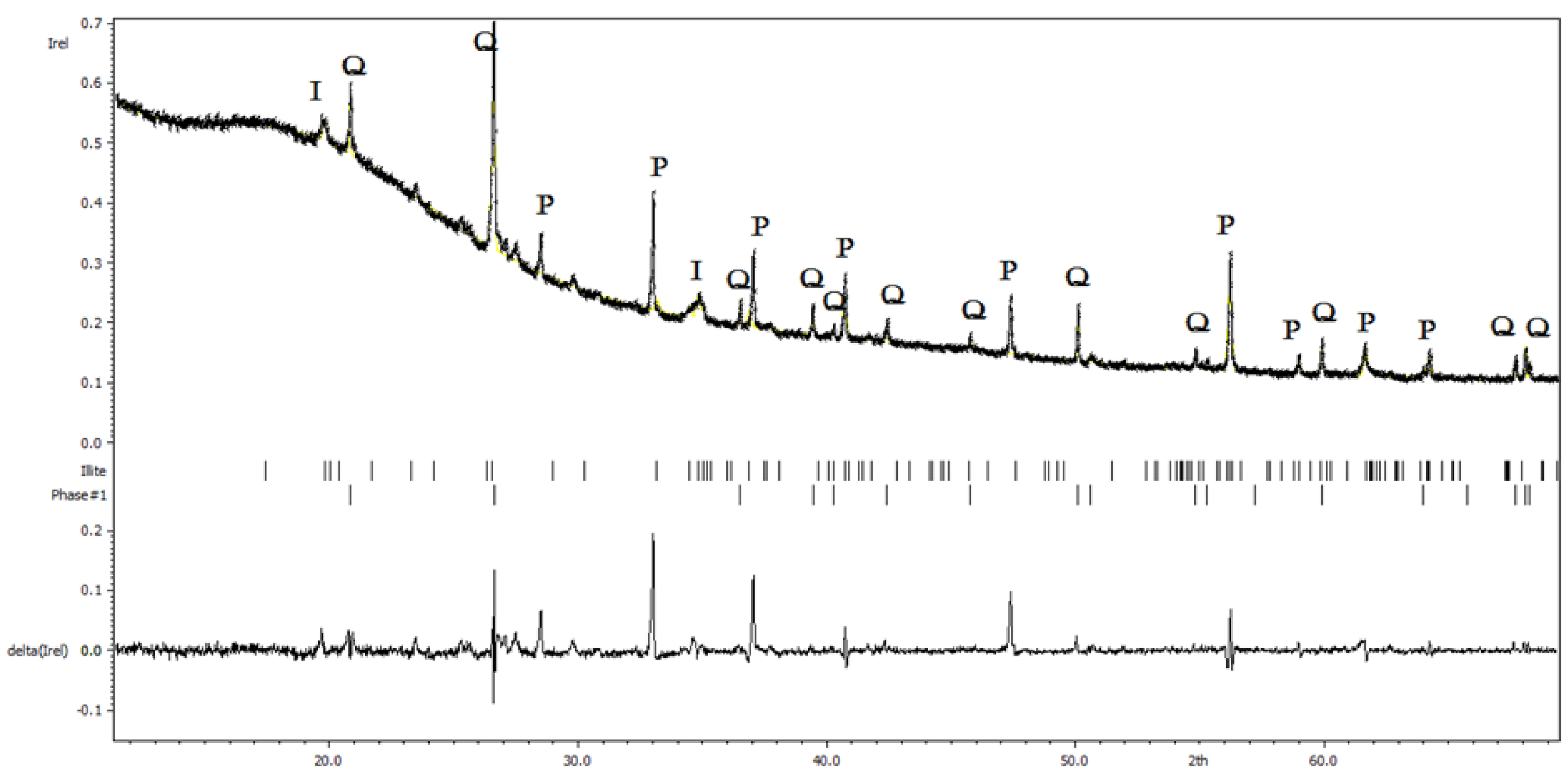
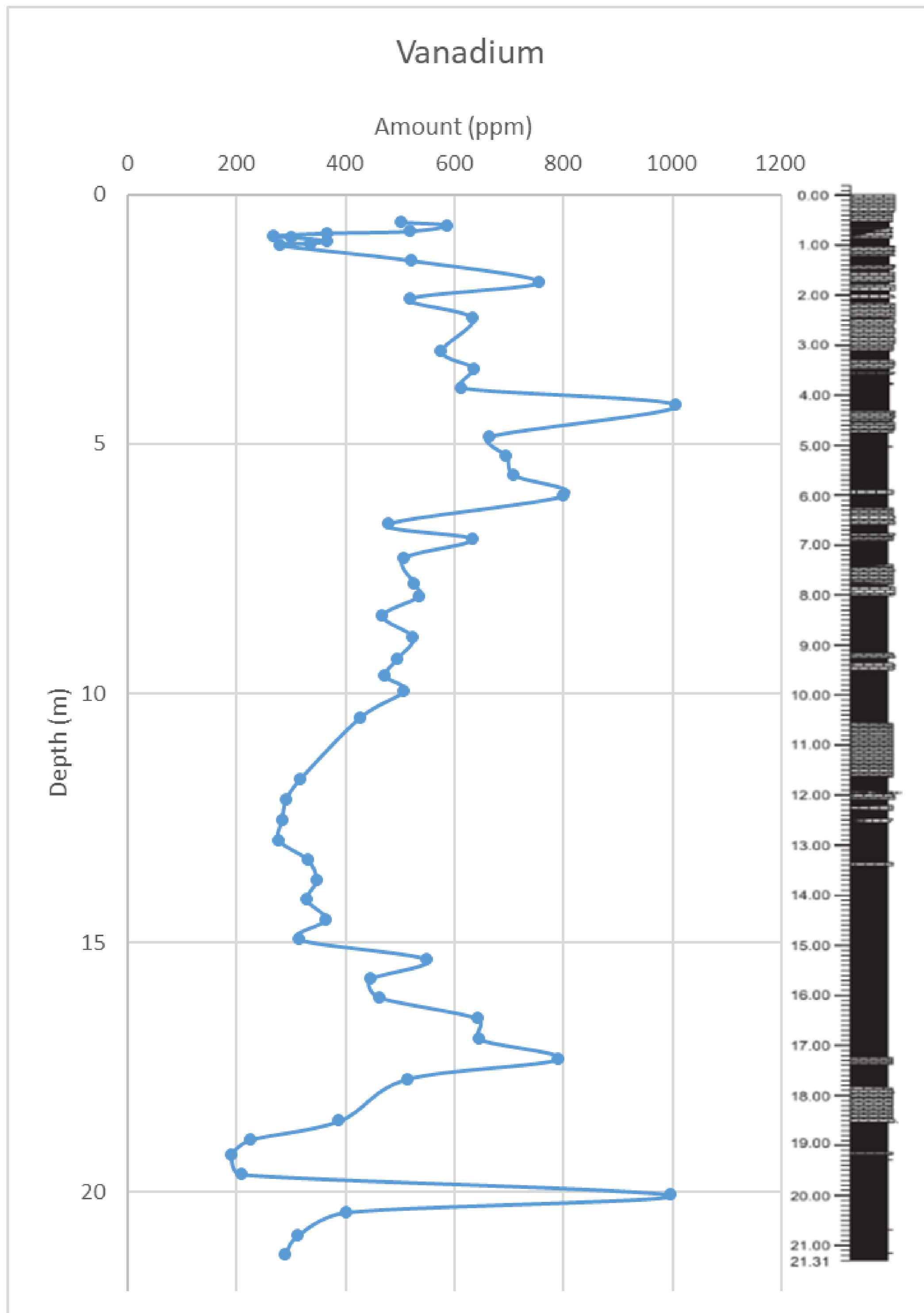
Exploitation of alum shale is a controversial subject in Sweden due to the history of pollution of the environment and groundwater, from past mining industries. The extraction of vanadium from alum shale is no different. Nevertheless the metal is a valuable resource used in tools, building, industries and aerospace materials. A look to the future reveals that vanadium may play a role in renewable energy. Vanadium redox flow batteries can store large amount of energy utilizing the many oxidation state of vanadium. This could help the problem of energy storage many sources of renewable energy faces.

This project is devoted to give a better understanding of how vanadium is bound and accumulated in the Cambrian Alum Shale Formation of southern Sweden, with the hope that this knowledge can help find an environmental friendly process to extract vanadium from alum shale with future research. In this project a drill core penetrating the Alum Shale Formation at Kinnekulle, has been analyzed with x-ray fluorescence spectroscopy, x-ray powder diffraction, x-ray photoelectron spectroscopy, IR-spectroscopy and a total organic carbon analysis. The aim is to identify the chemical state and evaluate possible correlations between vanadium, trace elements, organic carbon and minerals.



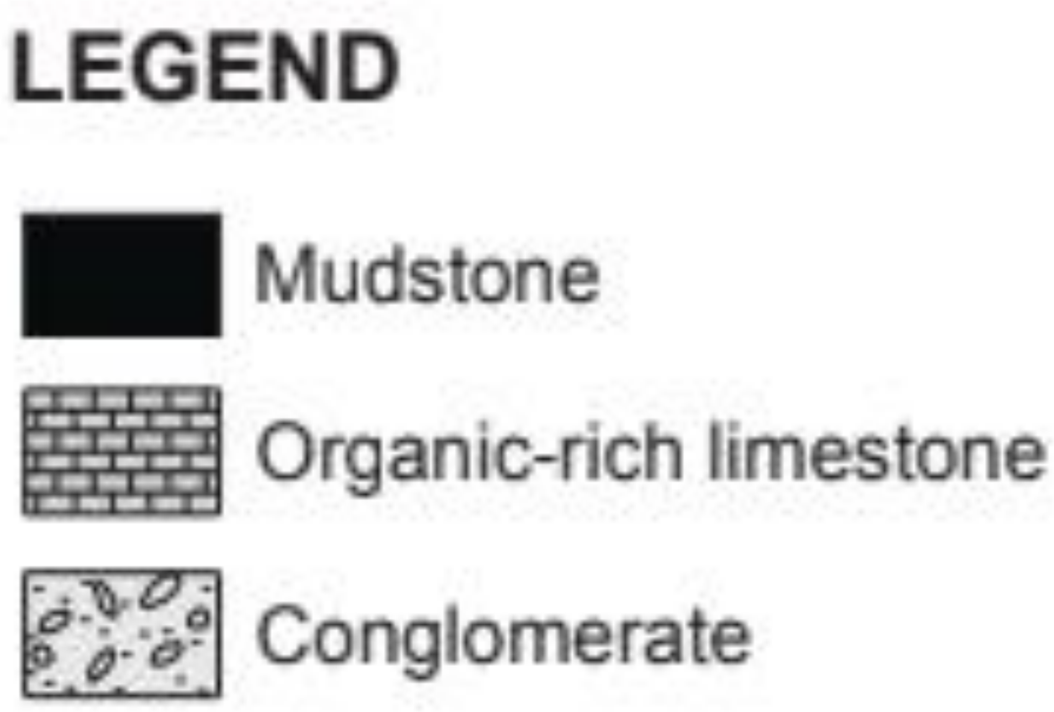
The diffractogram of the x-ray powder diffraction, with relative intensity at the y-axis and the angle 2theta at the x-axis, of a sample at 12,95 m with strong pyrite peaks, weak illite peaks and a low amount vanadium of 280 ppm.



A graph showing how vanadium, with amount (ppm) on the x-axis, vary with depth (m) on the y-axis, throughout the alum shale segment of the drill core.

Vanadium was found to be increasing towards the top of the, as seen in the graph to the right, probably due to increasing organic carbon. Strangely there was a decrease in the top-most section. Illite, the suspected main carrier of vanadium, had a very low signal in the x-ray powder diffraction, as seen in the diffractogram, organic matter is proposed as a major carrier of vanadium. Other results shows that the alum shale was enriched in several trace elements, such as vanadium, barium, molybdenum, uranium, lead, copper and nickel, compared to Clarke values of black shale. And the ratio of V / (Ni + V) implies that the level of anoxia in the waters at the time of sedimentation showed a sudden rise in dissolved oxygen at 1,02 m.

The Alum Shale Formation in the Kinnekulle drill core (recovered 2016 M. Calner, Department of Geology, LU) *displayed. The lowermost part of the formation are to the left, where also 1,5 m of the underlying lower Cambrian sandstone can be seen. Simplified; the black areas are organic-rich black shale and the grey areas are bituminous limestone*



A log of the Alum Shale Formation drill core showing mudstone, organic-rich limestone and conglomerates. Modified picture (from F. Lundberg, Department of Geology, LU).