Developing a Workflow to Quantify Critical Mineral Content in Fine-Grained Sediments: Case Study of the Dunkirk Shale Exposed along the Lake Erie Shoreline

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ABSTRACT

The challenge to find new and abundant sources of critical minerals is a looming issue for geoscientists worldwide. Given the limited domestic availability of traditional sources of critical minerals, including igneous and metamorphic terrains, the hunt is on for other supplies in the United States. Recently, the Critical Minerals Mapping Initiative (CMMI), a cooperative agreement between the Geological Surveys of the United States, Canada, and Australia, announced that sedimentary basins are an essential area to study for new sources of critical minerals.

Sedimentary rocks containing critical minerals are mined everyday as a by-product of oil and gas drilling procedures. This waste product can be a useful supply of battery metals including Co, Ni, and V and other base and minor metals including As, Ba, Sr, Mg, Zn, and Cu. Critical minerals are concentrated in fine-grained sedimentary rocks in three distinct ways. The first is through the weathering, transport, and sedimentation processes from igneous and metamorphic terrains that move critical mineral-rich sediments to various sedimentary environments. The second is through chemical processes that are present in shale environments and are influenced by sea water chemistry (oxygen and sulfur concentrations) and nutrient availability (carbon, nitrogen, and phosphorous). Finally, hydrothermal fluid flow associated with thermal maturity anomalies, can concentrate and redistribute critical minerals within sedimentary rocks.

Within the sequence of Devonian-aged Dunkirk Shale, our team has identified geologic environments where critical minerals can be enriched based on depositional and diagenetic histories. Starting with a field-based approach to collect and document rocks within a geologic framework, the team has analyzed metal content relative to geologic mechanisms that concentrate critical minerals of interest. Results from this work will be presented along with the status of the workflow. Once developed, this workflow

Douds, A. S. B., D. R. Blood, and S. D. McCallum, 2021, Developing a workflow to quantify critical mineral content in fine-grained sediments: Case study of the Dunkirk Shale exposed along the Lake Erie shoreline: GeoGulf Transactions, v. 71, p. 377–378.

can be transferred to other fine-grained deposits in other sedimentary basins.