Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.23639

Re-Os Geochronology of hydrothermal flake graphite in Amitsoq, South Greenland

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The Amitsoq Graphite Deposit is an exceptionally high-grade (>20 wt%) flake graphite deposit, with a total resource estimate of more than 4.7 Mt graphitic carbon. Graphite mineralization in South Greenland is hosted within the fore-arc of the Paleoproterozoic Ketilidian Mobile Belt in amphibolite-facies psammite. The Amitsoq graphite is thus likely of Paleoproterozoic age, a time which comprises many of the highest-grade graphite deposits on Earth. These high-grade Paleoproterozoic-aged graphite deposits are thought to represent a unique period of deep carbon burial and remobilization during the Paleoproterozoic [1].

Recent studies have shown promising results in applying the Re-Os system to the direct dating of graphite, which was previously age-constrained only by the dating of associated phases within the host rock. This development has provided initial support for the hypothesis of a major deep carbon cycling event in the Paleoproterozoic by linking hydrothermal graphite mineralization to periods following major orogenic events in the assembly of the supercontinent Nuna at ca. 2.0-1.6 Ga [2]. Our study applies Re-Os dating to the Amitsoq Graphite to determine whether this process occurred within the Ketilidian orogeny, another orogenic belt involved in the formation of Nuna.

The Re content of Amitsoq graphite varies from 17-104 ppb and Os between 0.2-4.1 ppb, indicating general suitability for Re-Os dating. We have obtained preliminary isochrons indicating an age of ca. 1680 Ma for graphite within the Amitsoq deposit. Isochrons yield initial 187Os/188Os ratios of between 1.3-1.6, indicating a more evolved, crustal osmium source. Our preliminary age data suggests that graphite mineralization was a late- to post-tectonic event following cessation of the Ketilidian orogeny (ca. 1850-1720 Ma), agreeing with previous Re-Os studies on graphite that indicate a graphite formation of 30-60 Ma after major periods of orogenic crustal accretion [2]. The Re-Os dating presented here and earlier Re-Os work on hydrothermal graphite, when paired with the ca. 1.85-2.0 Ga global peak of black shale deposition and organic carbon burial during the Shunga event, likely represent a critical couplet in Earth's carbon cycle during the Paleoproterozoic.

[1] Parnell (2021), *Geological Magazine* 158(9), 1711-1718
[2] Toma (2023), *University of Alberta* PhD Dissertation