

Preservation of Fe isotope compositions of iron formation during contact metamorphism

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We have analyzed a suite of minerals from iron formation samples of varying metamorphic grade (<150° C to >600°) and determined that heterogeneities in $\delta^{56}\text{Fe}$ survive contact metamorphism. The lowest grade rocks from the 1.9 Ga Biwabik Iron Formation are comprised of quartz, magnetite, siderite, greenalite and locally minnesotaite. Layering is on the scale of millimeters to a few centimeters. The contact aureole developed adjacent to the 1.1 Ga Duluth gabbro consists of 5 zones marked by the appearance of: 1) minnesotaite 2) grunerite 3) hedenbergite 4) olivine and 5) orthopyroxene.

The Fe isotopic compositions of primary, diagenetic, and metamorphic minerals were determined at the University of Hannover; results are reported relative to the IRM standard. Primary minerals analyzed include greenalite ($\delta^{56}\text{Fe} = -0.118\%$), Fe-carbonate (-0.913 to -0.430%), and hematite (0.122%). Their $\delta^{56}\text{Fe}$ are consistent with oxidative, fractionating precipitation of oxide from MOR-source aqueous fluids and precipitation of carbonates from residual $\text{Fe(II)}_{\text{aq}}$, although biologic involvement cannot be excluded.

Magnetite in the Biwabik Formation is predominantly a diagenetic mineral produced by reactions between hematite and ferrous iron in silicates and carbonates, or by reactions with carbonates that generate methane. $\delta^{56}\text{Fe}$ of diagenetic magnetite varies from 0.857 to 0.212, and is heavier than that of coexisting silicates and carbonates.

During contact metamorphism magnetite may break down but only petrologically insignificant amounts of magnetite can be produced by dehydration of Fe-silicates and dissociation of water. Metamorphic silicates are formed by various reactions involving silicates, carbonates and/or magnetite; the reaction products appear to inherit the approximate isotope composition of their reactant minerals. The $\delta^{56}\text{Fe}$ of these metamorphic minerals, which vary from -0.19 for olivine to +0.56% for grunerite, does not depend upon metamorphic grade. Instead, this study suggests that layer-to-layer heterogeneities in bulk $\delta^{56}\text{Fe}$ composition that developed during primary precipitation and diagenesis are preserved during contact metamorphism.

Mass-independent isotope effect in the isotope exchange reaction of chromium(III) using a crown ether

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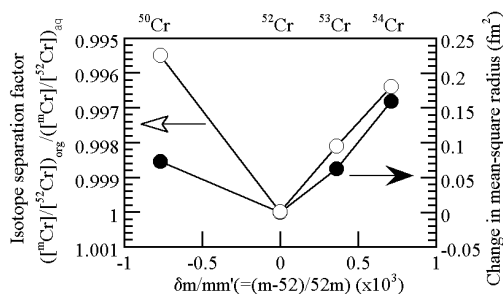
Mass-Dependent Isotope Effect and Mass-Independent Isotope Effect

In the research field of isotope chemistry, the conventional mass-dependent theory has been extended to include a mass-independent isotope effect (nuclear size and shape effect).

Isotope Effect of Chromium

Chromium isotopes were fractionated by liquid-liquid extraction system using dicyclohexano-18-crown-6. We found a mass-independent isotope effect. This shows a good relationship to the change in mean-square radius, $\delta\langle r^2 \rangle$.

Figure 1: Isotope separation factor and change in mean-square radius of chromium.



Some continuous extraction experiments were also performed, and the mass-independent isotope effects were observed. These isotope enrichment properties give the experimental facts of the nuclear size and shape effect.

References

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