Characterization of monazite from Big Thompson Canyon, northern Colorado with implications for geochronology and timing of Proterozoic tectonic processes

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Abstract

The Precambrian tectonic evolution of Northern Colorado and the Northern Front range is a complicated story of perhaps multiple tectono-thermal events, which despite years of study, remains relatively unconstrained. Big Thompson Canyon is a fruitful location to continue to unravel the complex geologic past of the region. The canyon is considered an excellent example of areally zoned metamorphism that consists of an arcuate pattern of metamorphic isograds that mark west to east, biotite-chlorite to staurolite grade rocks that may be the result of multiple phases of metamorphism and deformation over the hundreds of millions of year timescale. The resolution for this study was to collect and use electron microprobe data on monazites to date the growth of multiple staurolite generations in samples that contain both retrogressed and fresh staurolite isopach in hopes of a correlation to two separate metamorphic events. Here, we report the results of a preliminary investigation into the possibility of a 1.4 billion year old-overprinting event that may be preserved in the pelitic schists exposed in the Big Thompson Canyon region. These metamorphites are generally thought to be ~1.7 billion years old and experienced peak metamorphism around that time. An electron microprobe was used to take high-resolution images of monazite grains present in samples collected from Bob Cat Ridge were found and imaged using an electron microprobe and QEMSCAN. Several monazite grains were found in staurolite pseudomorphs, garnet and muscovite phyllosilicates. Resulting U-Th-total Pb data on monazites can be used to quantify the timing of crystallization of the fresh staurolite in the samples and thereby estimate the age of a second possible metamorphic event. The timing of the fresh staurolite formation allowed for inferences to be made about the geochronology and timing of Proterozoic tectonic process within Big Thompson Canyon and the northern Front Range as a whole.

Methods

I. Petrographic Observations

Each thin section was analyzed to determine overall metamorphic textural present. Petrographic observations were then used as a way to qualitatively confirm patterns in the QEMSCAN data.

II. QEMSCAN

Accessory maps were made to highlight monazite, zircon, xenotime and biotite. Photographs were then used as a way to determine average grain sizes and what the monazites were included in.

III. Electron Microprobe

An electron microprobe was used to take high-resolution images of monazite grains.

Results

I. Grain Size

Ideally we want large grains that contain several compositional domains because each domain may be a different age. We examined each thin section and found that there are plenty of monazite grains that are suitable to date.

II. Which minerals are the monazite grains included in?

A majority of the monazite grains are included in the matrix in all three thin sections. The second most common mineral the monazites were found in are in biotite.

Discussion

The Precambrian tectonic evolution of northern Colorado and the Northern Front Range is a complicated story of perhaps multiple tectono-thermal events, which despite years of study, remains relatively poorly understood.

The timing of the fresh staurolite formation allowed for inferences to be made about the geochronology and timing of Proterozoic tectonic processes within Big Thompson Canyon and the northern Front Range as a whole.