Combined U-Th-Pb monazite and Lu-Hf garnet ages from the Alpine Schist: Implications for the timing and duration of Barrovian metamorphism in the Southern Alps, New Zealand

Sophie Briggs*, John Cottle, Graham Hagen-Peter
Department of Earth Science, University of California Santa Barbara, *sbriggs@umail.ucsb.edu

Introduction and objectives

The Alpine Fault plate boundary in New Zealand has exposed a cross-section through greenschist- to amphibolite-facies Alpine Schist that extends for over 230 km along the Southern Alps (Fig. 1). The Alpine Schist offers an ideal location to investigate the timescales of Barrovian-type metamorphism and terrane accretion at the eastern Gondwana subduction margin. Existing ages of metamorphic minerals in Alpine Schist are scarce and range from 100 – 70 Ma (Fig. 1). We combine monazite LASS (laser ablation split-stream) geochronology with Lu-Hf garnet geochronology from samples distributed along the Alpine Fault. Prograde garnet ages from two preliminary samples range from ~115 – 105 Ma, while monazite and xenotime from 15 km away record growth at 78 – 70 Ma.

Implications and discussion points

- Preliminary Lu-Hf garnet ages (Fig. 2) are consistent with a published Sm-Nd mineral – whole-rock age from the Mataketake Range area (Mortimer and Cooper, 2004).
- Monazite and xenotime ages are significantly younger than new and published Sm-Nd and Lu-Hf garnet – whole-rock ages (Vry et al., 2004). Three possible explanations are:

  1. 70 Ma signature records the timing of peak temperature mineral growth.

  2. Fluid influx associated with pegmatite intrusion in the Mataketake Range area resulted in fluid-assisted mineral growth at ~70 Ma (Fig. 3).

  3. The garnet-bearing rocks and monazite-bearing rocks underwent different P-T-t paths.
- High Lu/Hf garnet may mask younger, low Lu/Hf garnet growth stages.
- Monazite U-Th-Pb ages are not disturbed by monazite alteration to apatite + allanite + REE-epidote.

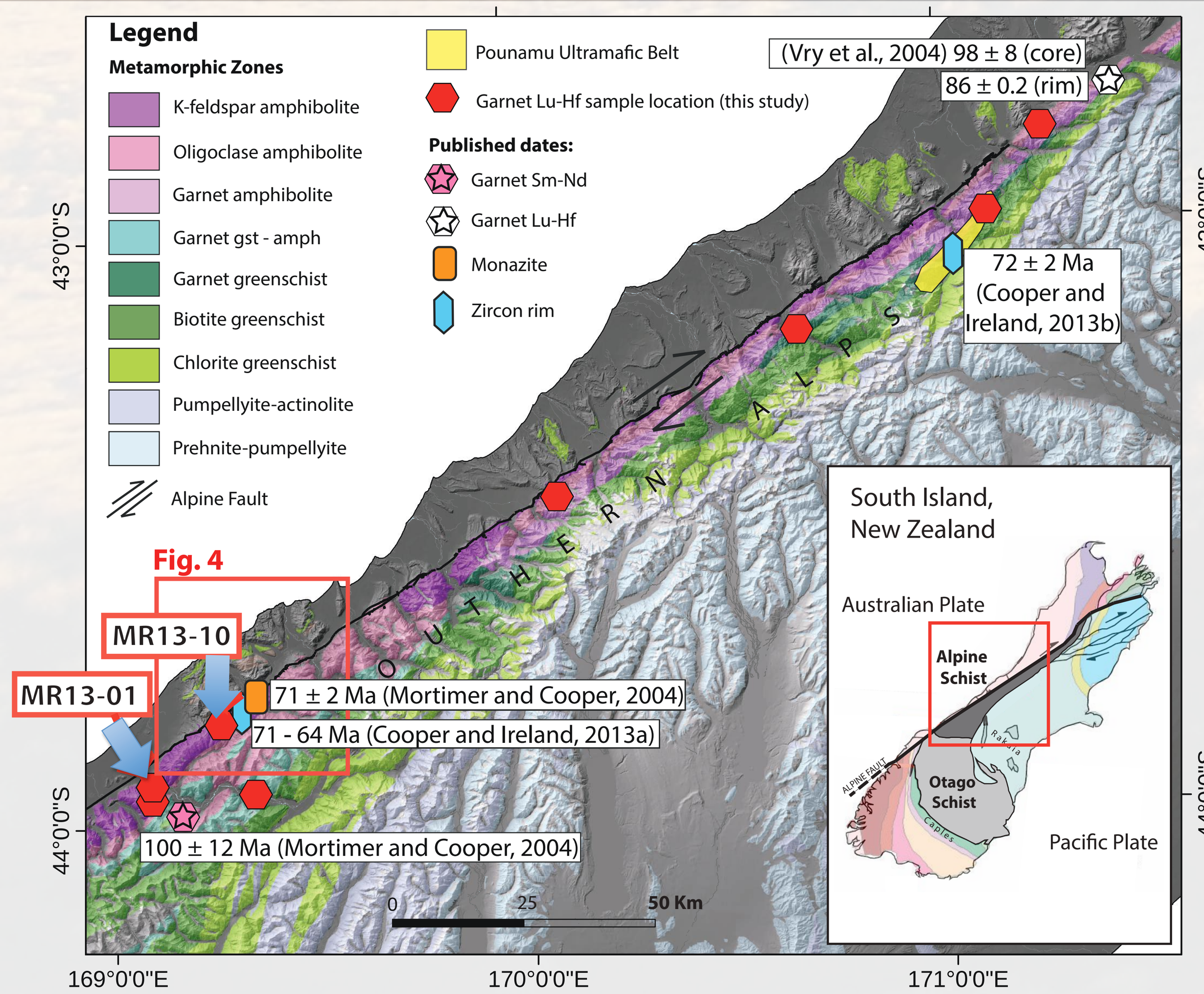


Fig. 1: Map of the Alpine Schist showing sample locations

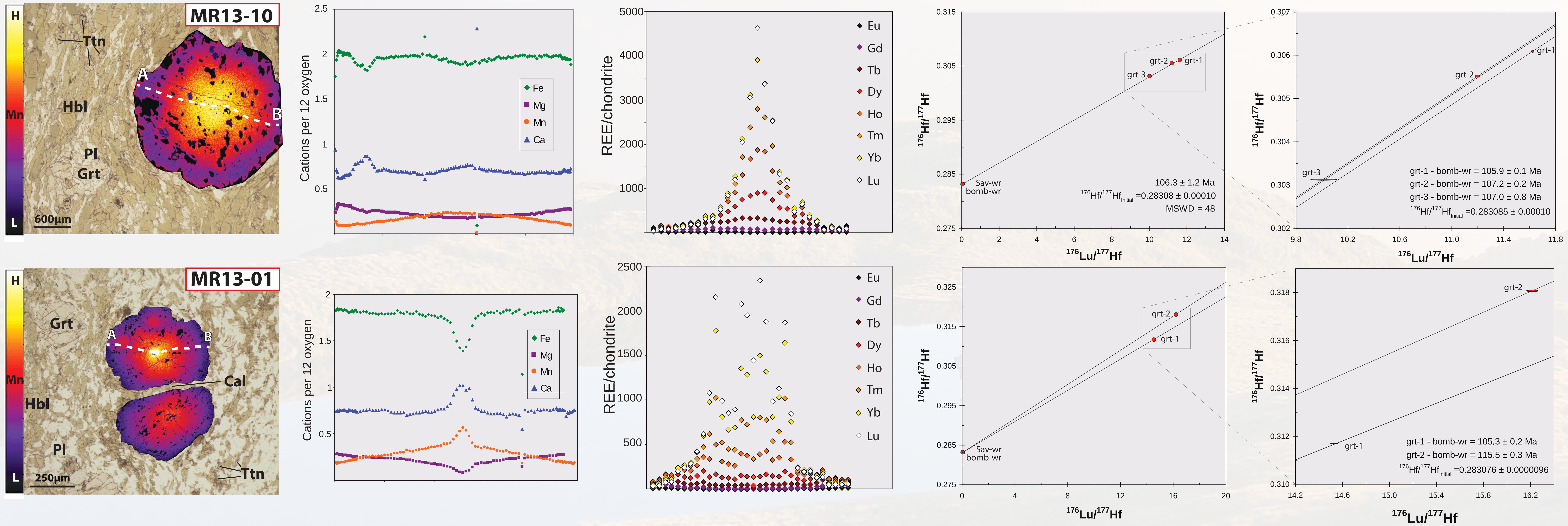


Fig. 2: Garnet chemistry and Lu-Hf garnet geochronology from two garnet-amphibolite schists (MR13-01, MR13-10). Major element data were measured by EPMA, REE data were measured by LA-ICPMS. MR13-10 garnet shows typical prograde zoning in major elements with HREE concentration in the core of the grain. MR13-01 shows a spike in major element concentration in the core and a sharp decrease in HREE toward the rim. Garnet separates were not categorized by grain size or inclusion density. Whole-rock fractions include both pressure digestion vessel (bomb) and Savillex-digested fractions. Garnet – whole-rock isochrons have high MSWD values due to the unusually high $^{176}Lu/^{177}Hf$ of metabasites. Two point garnet – whole-rock isochrons demonstrate some variation between the garnet points, which brackets the multi-point isochron age.

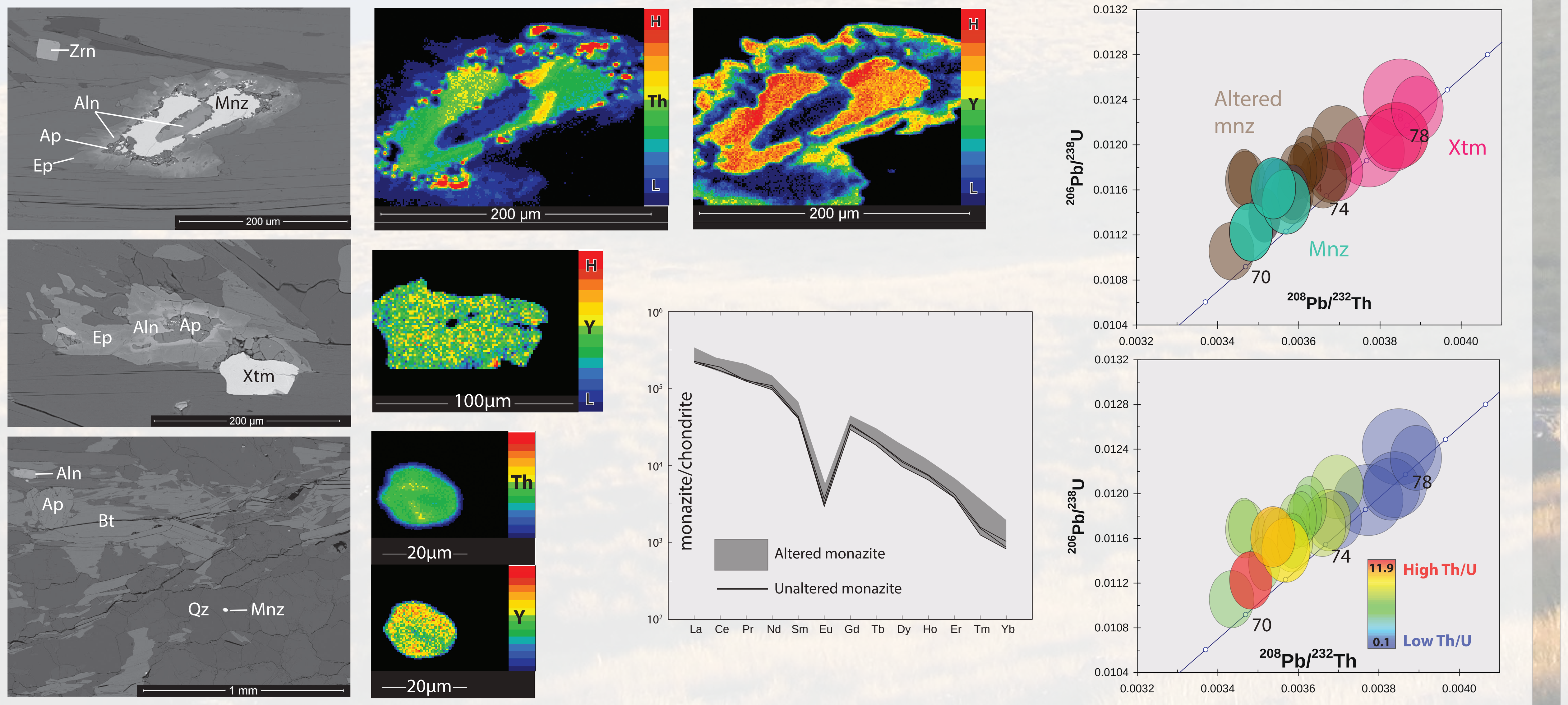
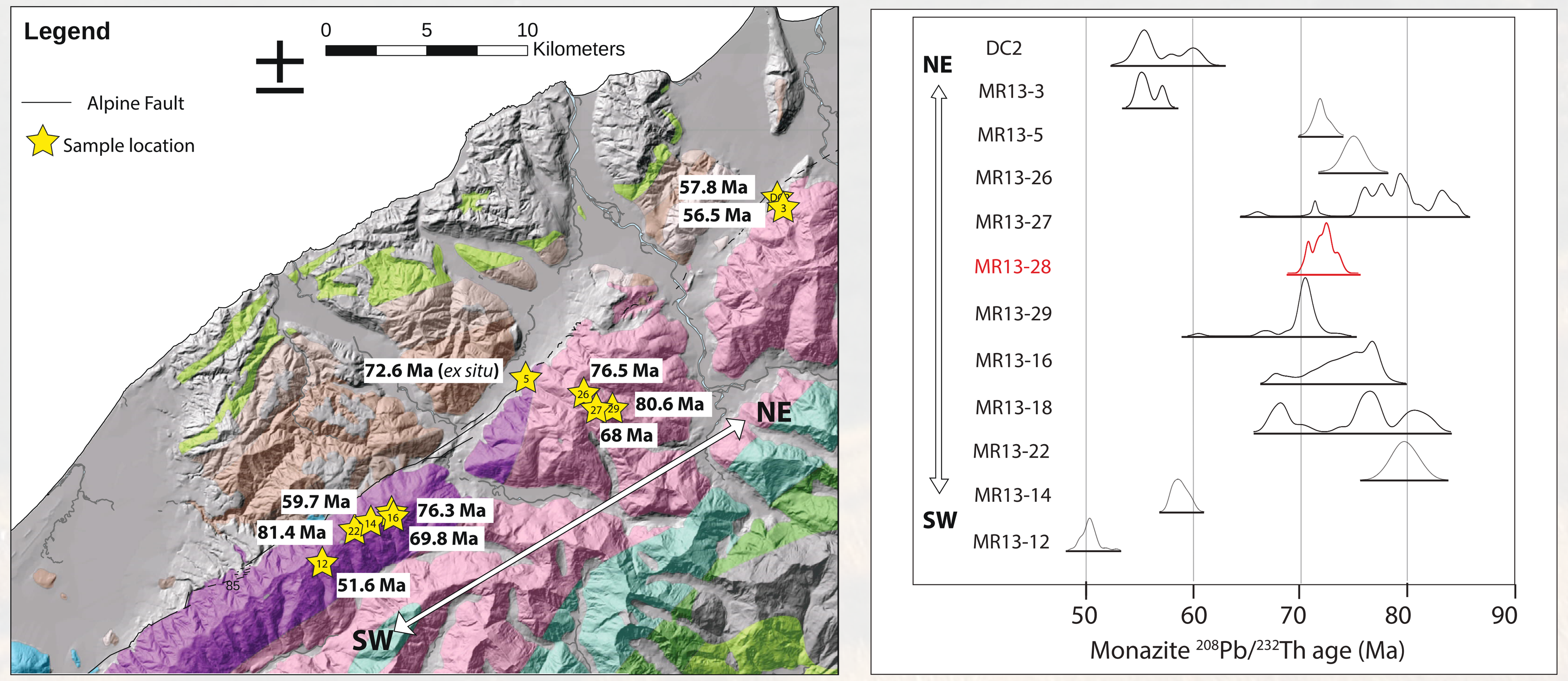


Fig. 3: Monazite and xenotime LASS-ICP-MS data from a quartzo-feldspathic gneiss (MR13-28; Qz-Pl-Ksp-Bt-Ms-Ilm). Monazite occurs 1) altered to apatite – allanite – REE-epidote coronas in biotite and 2) as unaltered grains in quartz/plagioclase. Th is concentrated as thorite inclusions in apatite and Y is concentrated in the REE-epidote rim. Unaltered monazite has higher Th/U but similar REE profiles as altered monazite. Geochronology shows that U-Th-Pb systematics are not disturbed by monazite alteration processes.



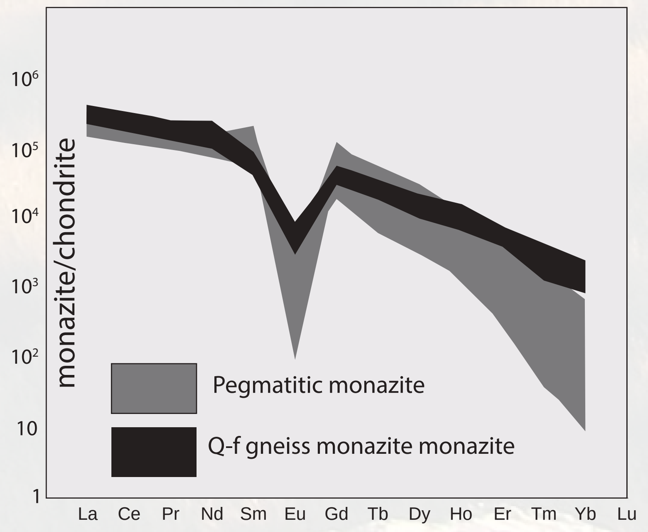


Fig. 4: Anatectic pegmatites from the Mataketake Range intrude quartzo-feldspathic gneiss host rock. MR13-28 was collected ~50 m from pegmatite outcrops within the zone of highest pegmatite abundance. Pegmatites yield a monazite $^{208}Pb/^{232}Th$ age distribution which envelopes that of the monazite bearing quartzo-feldspathic gneiss (MR13-28, Fig. 3). Monazite REE profiles reflect modal garnet abundance.

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