SUPPLEMENTAL File 2

Mid-crustal deformation of the Annapurna-Dhaulagiri Himalaya, central Nepal: An atypical example of channel flow during the Himalayan orogeny

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See main article for references and abbreviations

1. Electron microprobe analyses

2.1. GARB-GASP thermobarometry

Garnet grains in samples P12/058 and P12/060 are 5-10 mm and 0.5-1 mm in diameter respectively and are euhedral to subhedral. Garnet grains in P12/055 are 0.5-5 mm in diameter and are anhedral, with the largest grains showing signs of resorption. Garnet rims and cores and biotite and plagioclase cores were analysed and line-traverses with ~50-100 µm spacing between spot analyses were conducted on the largest grains. The largest biotite grains furthest away from garnet grains were selected for analysis to limit the effects of diffusion between garnet and biotite after metamorphism (Dasgupta *et al.*, 2004). If present, biotite and plagioclase grains in the middle of biotite and plagioclase amalgamations, respectively, were preferentially chosen to further limit the effects of re-equilibration (Dasgupta *et al.*, 2004). Zoned plagioclase was generally avoided but when analysed, the most internal zone was selected. A 4% H_2O content is assumed for biotite compositions (e.g. Fleet, 2003).

In order to account for re-equilibration and retrograde net transfer reactions (e.g. Frost & Chacko, 1989; Kohn & Spear, 2000), the methods of Kohn *et al.* (1992) and Corrie and Kohn (2011) were followed to identify peak metamorphic garnet compositions as those with the lowest Mn and Fe/(Fe+Mg) concentrations from a transect of multiple analyses from core to rim. In samples P12/055 and P12/060 the smallest garnets were excluded as these had homogenous compositions with Mn and Fe/(Fe+Mg) concentrations equal to the highest Mn and Fe/(Fe+Mg) concentrations of the larger grains and are therefore unlikely to represent peak metamorphic compositions. Individual garnet grain compositions were paired with a sample average biotite core composition (temperature) and a sample average plagioclase core composition (pressure) to determine peak PT estimates. Peak temperatures and pressures were calculated simultaneously for specific garnet grains using the TWEEQU method (Berman, 1991) with the winTWQ v2.32 software (Berman, 2007) and the thermodynamic database of Berman and Aranovich (1996). Individual garnet peak temperatures and pressures were then used to calculate an average peak temperature and pressure for each sample. Errors for temperature estimates were calculated from one standard deviation of the average sample temperature, plus the errors associated the calculations, as determined by the winTWQ software.

2.2. Zr-in-titanite thermometry

Titanite grains are subhedral to anhedral and often tabular in shape, with grain sizes ranging between ~50-400 µm. Some grains display patchy zonation in BSE images and a minority display oscillatory zonation, but most appear homogeneous. Zircon was identified in all samples, whilst rutile was not observed. Spot analyses were conducted on the largest

titanite grains on rims, cores and individual zones (where present), except for P12/054 where only cores were analysed.

Temperatures were calculated from the sample average titanite Zr concentrations (ppm) at an assumed pressure of 11 kbar, $a(TiO_2)$ of 0.8 and $a(SiO_2)$ of 1, based on constraints from Corrie and Kohn (2011) and Iaccarino *et al.* (2015). Errors were calculated from one standard deviation of the average temperature, plus the error associated with ±1 kbar pressure and ±0.2 $a(TiO_2)$.

(a)

Mineral Analysis	Acclerating Voltage (kV)	Current (nA)	Beam size (µm)	Count times (s) Si	Ti	Al	Cr	Fe	Mn	Mg	Ca	Ba	Na	K	F
Biotite + Plagioclase	15	10	2	10	20	10	20	30	20	20	20	15	10	10	40
Garnet	15	30	<1	10	20	10	20	30	20	20	20	-	10	10	-

(b)

Samples	Acclerating Voltage (kV)	Current (nA)	Beam size (µm)	Count times (s) Nb	Si	Zr (PETJ)	Zr (PETH)	Zr (PETH)	Ti	Al	Fe	Ca	K	F
P12/053, P12/054A	15	200	1	80	10	240	180	200	10	20	40	10	40	-
P13/031, P13/032				90	10	240	180	205	10	20	40	10	40	200

Supplemental Table 1. Electron microprobe analytical conditions and on-peak count times for each element analysis. High and low off-peak count times are half on-peak count times. (*a*) Garnet-biotite major element analysis set-up. (*b*) Titanite trace element analyses set-up. Zr concentrations were analysed with three spectrometers using PETJ and PETH crystals.

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