The University of Oxford Department of Earth Sciences

EARTHSCIENCES

UNIVERSITY OF OXFORD

Regional metamorphism and melting in the Langtang Himalaya, Nepal

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Key Words	**Himalaya, tectonics, metamorphism, crustal melting, geochronology**

Overview

The Himalayan Range is the best exposed and most intensely studied example of a collisional mountain belt on Earth today. Gaining a better understanding of its tectono-thermal evolution aids refinement of geodynamic models of plate boundary interactions, improved constraints on the rates and timescales of tectonic processes, and can shed new light on understanding interactions between changes in topography and local or global climate systematics (e.g. the Asian monsoon; Tada et al., 2016).

Himalayan metamorphism resulted from crustal thickening following the collision of India with Asia at c. 50 Ma (St-Onge et al., 2013). Along the Greater Himalayan Series (GHS) unit, the core of the Himalayan orogen, normal clockwise pressure–temperature (*P*–*T*) paths peak at kyanite-grade conditions of pressures up to ~1.0 GPa and ~625–720 °C, reached during the period ~45–32 Ma (Searle et al., 1997). Decompression to sillimanite-grade conditions is characterised by *P*–*T* conditions of approximately 8–4 kbar and ~750–650 °C, with widespread partial melting generating migmatites and leucogranite sills and dykes (Fig. 1: Searle et al., 2009). The earliest evidence for melting in the Himalaya comes from kyanite-bearing migmatites, which are prominent in Nepal.

The majority of the early, high-pressure melt fractions in the central Himalaya formed from muscovite dehydration melting, producing characteristic garnet-, muscovite- and tourmaline-bearing leucogranites. Later low-pressure melts include rare andalusite- and cordierite-bearing leucogranites that crystallized at <5 kbar (Dyck et al., 2020). All of these rocks types are present along the top of the GHS unit in the Langtang Himalaya of Nepal, although their field relationships remain poorly documented. This project will involve detailed structural mapping of the upper GHS in the Langtang Lirung region, combined with detailed petrographic analysis, pressure-temperature (PT) phase diagram modelling, and *in situ* U–(Th)-Pb geochronology. These data will be used to constrain the full metamorphic history of the Himalayan metamorphic core, including prograde to retrograde metamorphism and the evolving stages of decompression melting. The results will enable a detailed comparison between the processes and timing of metamorphism and orogenesis documented in older Phanerozoic and Precambrian collisional orogenic belts (Weller et al., 2021), with a view to investigating how plate tectonic processes have changed through time.

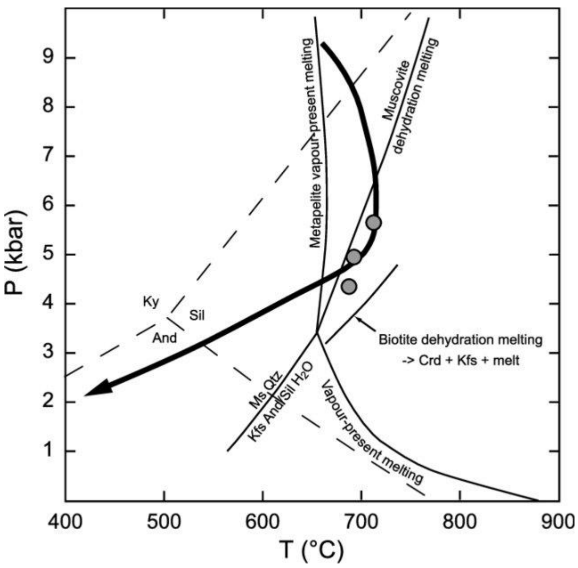

Figure 1. Pressure–temperature (*P*–*T*) diagram with equilibria and a schematic *P*–*T* path relevant to melting in the GHS (from Searle et al., 2009).

The project will involve two field seasons mapping and sampling in Nepal (under the supervision of Mike Searle and Marc St-Onge), accompanied by detailed microprobe and SEM analytical work and metamorphic modelling in Oxford (under the supervision of Richard Palin), and detailed U-(Th)-Pb dating of accessory phases (e.g. zircon, monazite, xenotime) at the National Environmental

Isotope Facility (Keyworth; under the supervision of Nick Roberts).

Methodology

A student working on this project will gain experience in the following tools and techniques:

- Field work, structural mapping and identification of mineral assemblages and deformation fabrics in the field
- Optical microscopy
- X-ray fluorescence (XRF) analysis
- Scanning-electron microscopy (SEM)
- Electron probe micro-analysis (EPMA)
- Laser ablation inductively coupled mass spectrometry (LA-ICP-MS)
- Petrological modelling (e.g. software such as THERMOCALC and Perple_X)

Timeline

Year 1: Doctoral training courses, literature review, fieldwork planning, fieldwork and sample collection, sample characterisation, and laboratory training.

Years 2 and 3: Follow-up fieldwork. Microanalytical work (XRF, SEM, EPMA), isotope geochronology (LA-ICP-MS), and petrological modelling. Data compilation and interpretation. Presentation of results at domestic and international conferences.

Year 4: Data integration, thesis completion, write papers for submission and publication in scientific journals.

Training & Skills

The successful student will join the [Hard Rock research group] at the University of Oxford, UK, which has a long-standing history of research excellence in metamorphism, magmatism, and metallogeny. They will also have the opportunity to integrate with faculty at external institutions and industry partners at annual career fairs.

The student will be trained how to conduct a field campaign, how to prepare and characterise geological thin sections, and perform advanced petrological and geochemical analyses of igneous and metamorphic rocks. This will include hands-on work with SEM, EPMA, and LA-ICP-MS equipment in both Oxford and with partners at the British Geological Survey. Training will also be provided on how to conduct geochemical and petrological modelling of metamorphism, anatexis, and melt crystallization.

The student will also be mentored on how to prepare scientific results for presentation at international conferences and how to write papers for publication in high-profile, international journals.

References & Further Reading

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Further Information

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