Dating the depths of the Himalayan orogen

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The formation of the Himalaya is currently explained by two contrasting tectonic models that differ in their predictions for the sequence of deformation along the main structures. Therefore PTtD data would provide crucial field tests of the tectonic hypotheses.

Mafic and pelitic granulites exposed in the eastern Himalaya preserve tey, xtural evidence for a precursor high-pressure metamorphic event, the precise conditions of which are generally unrecoverable due to the later high-temperature overprint. U–Pb zircon geochronological and trace element data suggest that zircons crystallized at 14-15 Ma, which is interpreted to indicate the timing of HP metamorphism due to the lack of negative Eu anomaly, the depleted heavy REE signature and the low temperatures of crystallization. U-Th-Pb Monazite ages indicate that the near peak T conditions were attained shortly after and much later then in the somewhat lower grade area underneath separated by a ductile shear zone. Ti-in-zircon and Zr-in-rutile geothermometry further help to establish links between accessory mineral crystallisation and metamorphism. Finally, crystallization ages of deformed leucogranites suggest concomitant shift of deformation along the roof normal geometry shear zone towards the interior of the orogen, consistent with the exhumation of the high-grade rocks.

We suggest that rocks in the metamorphic core of the Himalaya were buried to greater depths and subjected to greater temperatures than in the central parts of the orogen, and were exhumed rapidly during the later stages of orogenic evolution.

Visualization and statistical methods for the interpretation of geochemical survey data

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An overwhelming amount of geochemical survey data is now available from government around the globe. These geochemical surveys are derived from bedrock, soils, stream sediments, lake sediments, glacial till, regolith, laterite and a range of other less common materials. These surveys are highly variable in their spatial sample site density, heterogeneous mixture of media, choice of size fractions, methods of digestion and analytical instrumentation, which complicates the assembly of large regional-scale datasets. These assembled sets of data often contain thousands of observations with as many as 50 or more elements. Although the assembly of these data is a challenge, the resulting integrated datasets provide an opportunity to discover a range of geochemical processes that are associated with underlying geology, alteration, weathering, base- and precious metal mineralization and anthropogenic effects [1].

Modern methods of evaluating data include the application of multivariate data analysis and statistical techniques combined with geographical information systems. The use of these tools can significantly assist in the task of data interpretation and subsequent model building. Leveling techniques are often required during the assembly of regional geochemical datasets. Geochemical data require special handling when measures of association are required. Because geochemical data are compositional in nature (i.e. ppm, wt%), the application of statistical methods requires the use of logratios in order to eliminate the effect of closure.

Exploratory multivariate methods include: scatterplot matrices, adjustments for censored and missing data, identifying atypical observations, computing robust measures of association, principal component analysis, cluster analysis and knowledge based indices of geochemical processes. The separation of geochemical data into target and background sets forms the basis of a modeled approach for discriminating and classifying data and the subsequent identification and confirmation of geochemical processes.

[1] Grunsky (2010) *Geochem. Expl. Env. Anal.* **10**, 27–74.