The differentiation of continental crust in arcs

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Processes resulting in the chemical stratification of the continental crust have since long been studied but, limited information is available on the extend and origin of stratification of the initial juvenile continental crust formed in arcs. This lack of knowledge renders the quantification of secondary reworking processes in the continental crust difficult. Here we present an extended dataset documenting the magnitude and nature of chemical stratification of the juvenile Kohistan arc crust. The Kohistan arc (NE Pakistan) is the only complete exposed arc section preserved in the geological record, ranging from upper mantle peridotites and ultramafic cumulates at the bottom to unmetamorphosed sediments at its top. The bulk composition of the Kohistan arc, formed during intra oceanic subduction, is andesitic and similar to the bulk continental crust [1]. As postcollisional secondary reworking processes in Kohistan are negligible, the chemical stratification observed of the Kohistan arc represents the best available initial stratification state of the juvenile continental crust formed in arcs.

We used in total ~60 own and published geobarometric results (Al-in-hbl and various net-transfer reactions) to constrain the (re)crystallisation depth of the different plutonic rocks of the entire Kohistan arc. The calculated (re)crystallisation pressures coincide well with inferred intrusion depths of the different units based on magmatic phase relationships and form a regionally consitent pattern of increasing pressures from the unmetamorphosed sediments in the north to the upper mantle peridotites in the south. We thus interpret the geobarometric results to generally reflect magmatic emplacement pressures. Based on these results, we used standard krigging methods to approximate the intrusion depth of > 200 sample for which geochemical whole rock compositions exist. The result is a profound chemical stratification between the lower and upper crust. Whereas the upper part of the crust is internally only weakly stratified and compositional rather homogenous the lower arc crust section is compositionally strongly stratified and complementary to the upper crust. This indicates that the juvenile continental crust formed in arcs inherits a strong primary compositional stratification before secondary (e.g. remelting) processes may set in.

[1] Jagoutz O. Schmidt M.W. (2012) *Chem.Geol.* doi:10.1016/j.chemgeo.2011.10.022

Multi-tool dating for polymetallic deposits (Antimony Line, RSA)

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The 3.09-2.97 Ga Murchison Greenstone Belt is one of several Archean volcano-sedimentary belts within the Kaapvaal Craton in southern Africa [1]. It hosts a variety of ore deposit types: VMS style Cu-Zn mineralization [2], pegmatite related emerald and orogenic-style Sb-Au deposits along the Antimony Line (AL), the latter an unusual Precambrian Sb-dominant set of deposits located in a major quartz-carbonate altered ductile structure. Various models (magmatic, volcanogenic-derived, orogenic-gold…) have been proposed for the AL, which emphasize its overall complexity.
The Malati Pump mine, at the eastern end of the AL, hosts Au-Sb mineralization in the cupola of one of a number of granodiorite plugs intrusive into the belt. Its U-Pb (Zircon) dating and Pb-Pb dating of the Au-Sb-related sulphides yield an age of 2.97 Ga, identical to the age of the VMS Cu-Zn and the emerald deposits. Thus the granodiorites emplacement was probably the main trigger for this polymetallic metallogenic system at different crustal levels (Fig).
The AL is also clearly related to hydrothermal fluid circulation. Albitites run along the AL and were developed at the expense of a granodioritic protolith. Their systematic enrichment in Sb highlights a genetic link between the Sb mineralization and the albitization process. U-Pb data on hydrothermal monazites spread along the Concordia from 2.8 down to ca 2.0 Ga. Chemical analyses on the dated monazite allow us to interpret the data as a Discordia (combination of a major fluid circulation at 2.8 Ga followed by a thermal/fluid event at ca 2.0 Ga) rather than as a multi-events system.

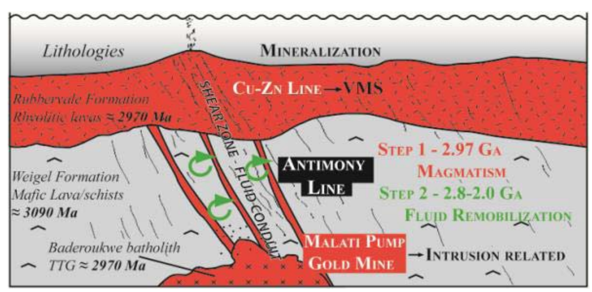

Figure: Model for the AL deposit formation and evolution.

Fluid dating is rather complex as is the AL system as a whole. This study illustrates that a combination of conventional U-Pb zircon dating to accurately identify the emplacement ages of the major meta-igneous host rocks, with Pb-Pb dating of sulphide minerals and U-Pb dating of monazites to date stages of mineralization, plus mineral chemistry studies of the various dated phases combined with $^{40}Ar/^{39}Ar$ geochronology represents a useful methodology for uncovering the history of metallogenically complex regions.

[1] Poujol et al (1996) *Econ Geol* **91**, 14551461. [2] Schwarz-Schampera et al (2010) *Miner Depos* **45,** 113-145.