Sapphirine granulites of the Gruf Complex (Central Alps, N-Italy): *In situ* monazite dating by SHRIMP and confocal synchrotron µ-XRF

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The age of granulites in the Gruf Complex has been a matter of debate, because of conflicting evidence from U-Pb dating of zircon mineral separates [1] and field evidence. We used a novel *in situ* confocal synchrotron technique for chemical U-Th-Pb dating of monazite to resolve this.

The use of chemical dating has been restricted by high detection limits (EMPA ca. 100 ppm) and low spatial resolution (µ-XRF ca. 150 µm). A confocal experimental set-up at the µ-spot beamline at BESSY II has been used here (excitation volume of ca. 20 µm), to allow *in situ* analysis in polished thin sections, in contrast to mini-XRF (e.g. [2, 3]). Three isotopically dated and chemically characterized mona-zite standards used to calibrate Ranchins formula parameters [4] yielded ages within < 4% of the isotopic results. The Pb detection limit is ca. 7 ppm for 1000 sec counting times.

The obtained chemical dates range from 32-86 Ma, the youngest of which agree within error with *in situ* analyses on the same grains by SHRIMP, which did not detect any older relics. The older chemical dates are thus artefacts produced by excess common Pb, dominant in such young grains at this low level of detection. 32 Ma can now be reliably interpreted as the age of the HT event in the Gruf Complex (coeval with the Bergell intrusion, because the monazites are inclusions in HT-minerals (orthopyroxene, sapphirine).

[1] Liati & Gebauer (2003) *Schw. Min. Petrol. Mit.* **83,** 159-172. [2] Cheburkin *et al*. (1997) *Chem. Geol.* **135,** 75-87. [3] Engi *et al*. (2002) *Chem. Geol*. **191,** 225-241. [4] Ranchin (1968) *Sci. Terre* **13,** 161-205.

Localisation of groundwater sources by combining $\delta^{18}O$, δD and Rare Earths studies

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Stable isotopes ($\delta^{18}O$ and δD) are commonly used to characterize the source of groundwater. Different from stable isotopes the distribution rare earth element (REE) in groundwater reflects the leachable components of sediments and rocks of the catchment area. This is because after a long time of W/R interaction REE adsorbed onto pore surfaces are in equilibrium with the percolating groundwater. This is also the case if the lithology changes. Thus, groundwater sampled from wells and springs still show the REY distribution pattern established in the catchment area. Only if the groundwater leaches soluble, REY-bearing salts from deeper aquifer rocks, different from the catchment, the REY pattern is varied. In Israel, groundwater from sandstones, Cretaceous and Eocene limestones, and basalts show distinctly different REY patterns. Applying the REY signature as a grouping criterion of groundwaters, $\delta^{18}O$ vs. δD plots yield a new dimension in interpreting isotope data. Examples will be shown from studies in Israel. For instance, the combination of isotope and REE data prove that the water extracted from the cover basalt of the southern Golan originates from the limestones of the Hermon Massif far north, thus proving long-distant movement of groundwater in this area. Groundwater from the cover basalt in the Bet Shean area originates from Eocene limestones further to the west. In the Arava Valley the groundwater extracted from the Graben fill of the adjacent mountains either originates from the Kurnub sandstone or the Judea limestones. These two water types occur side by side without significant mixing.

[1] Möller *et al*. (2003) *Appl. Geochem.* **18**, 1618-1628.