EGU21-8442, updated on 02 Dec 2021
https://doi.org/10.5194/egusphere-egu21-8442
EGU General Assembly 2021

Beyond ultra-high pressure metamorphism: evidence for extremely high pressure conditions during frictional fusion in gigantic landslides using micro-Raman spectroscopy of quartz: the Tsergo Ri (Langtang Himal, Nepal) rockslide

Peter Tropper[1], Kurt Krenn[2], and Diethard Sanders[3]
[1]University of Innsbruck, Institute of Mineralogy and Petrography, Innsbruck, Austria (peter.tropper@uibk.ac.at)
[2]University of Graz, Institute of Earth Sciences, Graz, Austria (kurt.krenn@uni-graz.at)
[3]University of Innsbruck, Institute of Geology, Innsbruck, Austria (diethard.g.sanders@uibk.ac.at)

The Tsergo Ri rockslide represents one of the world's biggest rockslides in crystalline rocks (original volume: 10^{10} m^3). The mass movement comprises migmatites, leucogranites, orthogneisses and paragneisses (Weidinger et al. 2014). During mass-wasting, frictionites and microbreccias formed at the base of the rockslide. The frictionite is mainly composed of a glassy matrix containing biotite, quartz, and abundant plagioclase and K-feldspar. Biotite locally shows a transformation to spinel + glass in highly glassy microdomains. Fe-rich layers in the glass indicate melting of biotite-rich layers of the protolith biotite-bearing orthogneiss. Locally, quartz grains are rimmed by a thin layer of SiO_2 glass (lechatelierite).

Investigations by McMillan et al. (1991) and Kowitz et al. (2013) have shown that shocked quartz shows a shift in the main A1 Raman mode down to lower wavenumbers with increasing pressures. Tropper et al. (2017) and Sanders et al. (2020) found that quartz from the frictionites in the Köfels landslide (Austria) shows a significant shift of up to 4 cm^{-1} in the main A1 Raman mode. Therefore micro-Raman spectroscopy was applied to quartz crystals with and without lechatelierite rims in the Tsergo Ri frictionites. Raman maps of quartz grain areas were prepared using a HORIBA Jobin Yvon LabRam HR800 micro-spectrometer equipped with a 30 mW He-Ne laser (633 nm emission).

Micro-Raman spectroscopy of 'normal' quartz yielded an intense A1 Raman mode at 464 cm^{-1}, whereas quartz without lechatelierite rims shows a shift of this band down to 461.5 cm^{-1}. The highest shifts down to 460.5 cm^{-1} were observed in quartz grains rimmed by lechatelierite. It is also noteworthy that these grains show an internal gradient of Raman shift of up to 3 cm^{-1} from the core (463.5 cm^{-1}) to the rim (460.5 cm^{-1}) to just below the lechatelierite rims. This is an important observation since lechatelierite formation in frictionites from rockslides was considered so far to be a function of temperature only. Because lechatelierite only rims quartz with strongly shifted A1 band numbers, we interpret lechatelierite formation to be driven by both temperature and pressure, at least under frictionite conditions. The completely molten granitic matrix and the breakdown of biotite to spinel + melt indicates minimum temperatures of 900-1000°C. Sanders et al. (2020) showed that the shifted A1 mode of quartz is stable only below 1100°C, thus giving an

upper limit of the temperature range. The observed Raman shift of the A1 mode and the presence of lechatelierite strongly suggest that a pressure of possibly >24-26 GPa was attained (cf. McMillan et al. 1991, Kowitz et al. 2013). The data from Köfels and Tsergo Ri provide the first quantitative estimates of peak pressures during frictionite formation, and show that UHP-modified quartz associated with lechatelierite is common in landslides of silica-rich rocks.

References:

Kowitz et al. 2013: Earth and Planetary Science Letters, 384:17

McMillan et al. 1992: Physics and Chemistry of Minerals, 19:71

Sanders et al. 2020: EGU2020-4831

Tropper et al. 2017: Mitteilungen der Österreichischen Mineralogischen Gesellschaft, 163: 89

Weidinger et al. 2014: Earth and Planetary Science Letters, 389:62