Thermometry of quartz mylonites

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We have investigated natural quartz mylonites from a well-studied area offering 'laboratory conditions in nature' to test the applicability of the Ti-in-quartz geothermometer [1] on rocks deformed in a temperature range from ~280-700°C.

Quartz mylonite samples were systematically collected across the Tonale fault zone (northern Italy) [2]. The eastern part of the fault zone was contact metamorphosed by the synkinematic intrusion of the Adamello pluton [2]. Across the ~800 m-wide ductile shear zone, this resulted in a synkinematic temperature gradient from ~280°C at the frictional-viscous transition to ~700°C at the pluton contact as derived from conventional thermobarometry [3, 4]. Deformation microstructures display the entire range of dynamic recrystallisation in quartz: bulging recrystallisation (BLG), subgrain rotation recrystallisation (SGR), and grain boundary migration recrystallisation (GBM) [4]. We have analyzed 18 samples from the shear zone on the SHRIMP-RG (reverse geometry) ion microprobe at Stanford University.

We demonstrate that the Ti-in-quartz geothermometer yields the near-peak temperature of deformation for the mylonites deformed at temperatures above ~500°C. However, in the mylonites deformed under lower temperature conditions, the previously established Ti concentrations were not reset. We suggest that this is due to the sluggish Ti diffusion rates below 500°C (cf. [5]) and the small volume-% of recrystallised grains. Our results show that GBM promotes the equilibration of Ti in quartz, while quartz mylonites deformed by SGR or BLG will likely yield inherited temperatures. In sum, for low-temperature mylonites (< ~500°C) the applicability of the thermometer strongly depends on how long the rocks stayed at these conditions and how intense were dynamic recrystallisation processes. Conversely, for high-temperature mylonites the question remains to which extent was the Ti concentration affected by retrogression and recrystallisation during exhumation.

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Aqueous solubility and speciation of Te(IV) at elevated temperatures

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Tellurium, although one of the elements with the lowest natural abundances, is a relatively common component in gold ores. Tellurium is the only element to form a variety of minerals with gold as essential component, eg calaverite, sylvanite, krennerite, petzite.

Despite the fact that this minerals are the main gold carrier in several major mines (Cripple Creek (Colorado), Emperor (Fiji), Săcărîmb (Romania), Golden Mile deposit (Western Australia)) the knowledge of the geochemistry of the gold tellurium association is still incomplete. A better understanding may be obtained by modelling the conditions of formation of these ore deposits. However, this requires a knowledge of which chemical species are present together with their thermodynamic properties. At the moment the thermodynamic data is relatively scarce for tellurium species especially at elevated temperature [1].

The present study is dedicated to obtaining thermodynamic data for the Te(IV) in aqueous solution at elevated temperature.

The solubility of TeO_2 between pH 2 and 11 has been determined by sampling adequate buffer solutions equilibrated with solid TeO_2 at different temperatures. Tellurium concentration was determined by ICP-MS.

The solubility reaches a minimum at pH 4 and increases by a factor 10 between 25°C and 80°C, from respectively 10^{-5}m to 10^{-4}m.

The solubility minimum corresponds to the formation of tellurous acid (H_2TeO_3):

$$H_3TeO_3^+ \square H_2TeO_3 \square HTeO_3^- \square TeO_3^-$$
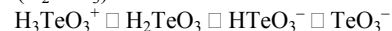
The acid dissociation constants have also been determined by ^{125}Te NMR at 140°C.

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