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Are I-type granites wet and cold? Notes from the Bergell intrusion in Switzerland

LUDMILA MARIA FONSECA TEIXEIRA[1], MICHAEL ACKERSON[1] AND OLIVIER BACHMANN[2]

[1]Smithsonian National Museum of Natural History
[2]ETH Zürich

Over the last few years, suggestions that some I-type silicic melts may be super-wet and/or crystallise at low temperatures have become recurrent in the literature. Understanding the crystallisation conditions of such systems is key to deepening our knowledge of how the continental crust forms, particularly regarding the genetic processes of ore deposits.

In this study, we use mineral chemistry and textural analyses to investigate the conditions under which the Bergell intrusion (Switzerland) and its mineralisation-free pegmatites formed. Zircon, quartz, apatite, and feldspar analyses indicate that pegmatites and granites share remarkable similarities in their composition and a partial overlap in crystallisation temperatures. Ti contents in quartz (< 50 ppm) and zircon (< 3 ppm) are generally low, resulting in low temperatures typically near or below the water-saturated haplogranitic solidus (~ 650-680 °C). FTIR analyses of large K-feldspar megacrysts in the granite show exceptionally high structural water contents (above 1000 ppm in the feldspar rims). Apatite compositions in granites and pegmatites, rich in F, hint at crystallisation in the presence of abundant fluids.

Together, these findings suggest that the Bergell melt, like other I-type occurrences (e.g. Adamello), may have been very wet and had significant portions crystallising at and below the traditional haplogranitic solidus. Due to the excess of water, pegmatitic fluids likely exsolved early in the system's evolutionary path (i.e. at lower crystallinities) and before the granitic system could concentrate critical elements via high degrees of fractionation, thus explaining their barren nature. Our results challenge some traditional models of granite formation and carry important implications for understanding the fertility of pegmatitic ore deposits.