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Looking at Cordilleran batholiths through phase equilibria: Experimental background and further research

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The production of large silicic batholiths (Cordilleran-type) dominantly composed by rocks of granodiorite to tonalite composition is the most outstanding consequence of plate subduction below active continental margins. Geochemical studies based on trace element abundances and isotopic ratios are insufficient to produce robust petrogenetic models. We show here that the study of phase equlibria can contribute to solve the most important paradoxical features of cordilleran batholiths. The available experimental data together with new experiments at variable pressures and temperatures have been adequately projected into pseudoternary diagrams in order to trace, in a first order approach, cotectic-like multisaturation lines. The position of these lines projected into the FeMg-Orthoclase-Anorthite system provides the best compositional space for calc-alkaline compositions. We show that the composition of multisaturation liquids is strongly dependent on pressure and water content. The comparison of natural petrological trends and phase equilibria predictions represents a new framework for granite petrogenesis. These are in agreement with the strong water undersaturation that characterizes calc-alkaline granodiorites and tonalites. The most outstanding implication of these results is the need for high temperatures (>1000 °C) that exceed the maximum thermal regime predicted by current models. Another implication is that open-system processes such as assimilation and magma mixing can be identified in the pseudoternary projections. The new model is applied to particular examples of batholitic associations from North America (Sierra Nevada and Peninsular Ranges batholiths), the Patagonian batholith and collisional batholiths from the European Caledonian and Variscan orogens. We propose here that more efforts in producing new and improved experimental data may produce considerable advances in understanding granite petrogenesis.