

The Last Glacial Termination in the Southern Alps, New Zealand

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Abstract

Resolving the timing of the last deglaciation in the Southern Hemisphere can aid discrimination among proposed mechanisms for the last glacial termination. Here, we present records of glacier behavior from three former glacier catchments of the Southern Alps, New Zealand, during the last glacial termination. We used ¹⁰Be surface-exposure dating and detailed glacial geomorphologic mapping to produce chronologies of well-preserved glacial landforms tracking the last deglaciation in the Southern Alps. We implemented a glaciological model to derive magnitudes and rates of paleo-snowline changes from our ¹⁰Be-dated geomorphological record of glacier behavior. Our glacier/palaeo-snowline reconstruction indicates that Southern Alps ice recession and warming took place in two rapid pulses, separated by an interval of cooling and glacier resurgence during late-glacial time. The timing of these warming pulses coincided with the initiation of stadial conditions in the North Atlantic Ocean. In this regard, we discuss the possible role of a bipolar seesaw mechanism for initiating and sustaining the last glacial termination in the southwest Pacific sector of the Southern Hemisphere.

Transient porosity as an integral aspect of microstructural development during fluid-mineral reaction.

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Whenever an aqueous solution interacts with a mineral with which it is out of equilibrium the resultant dissolution process is likely to result in an interfacial solution composition that is supersaturated with respect to different mineral or mineral solid solution phases. At this stage the transport properties of the solution and the probability of nucleation within this interfacial aqueous solution will determine the subsequent behaviour of the system. If the rate-determining step in the dissolution-transport-nucleation process is the dissolution rate, the nucleation of the new mineral phase will take place at the dissolving interface. The microstructural evolution of this solid-fluid two-phase product of the interface reaction depends on the possibility that it can continue to grow at the expense of the parent phase i.e. that the fluid can maintain contact with the parent phase at the migrating reaction interface. This will be the case if the volume of the product solid formed is less than the volume of the parent phase dissolved, allowing the fluid phase to occupy the difference. The solid volume deficit depends on both the molar volumes of parent and product phases and their relative solubility in the interfacial fluid [1]. The volume occupied by the fluid in this two-phase reaction product can be described as a porosity in the product solid. The product solid, together with the porosity which may be on a nanoscale, forms a microstructure characteristic of the reaction mechanism. As with all microstructures this is may be a transient phenomenon and subsequent textural equilibration (recrystallisation) in the presence of fluid may eventually eliminate the porosity. In contrast to microstructures formed in solid-solid reactions, the closure temperature at which no further reaction takes place may be as low as room temperature.

Examples of the microstructural development in natural and experimental fluid-mineral reactions will be given to illustrate these general principles [2].

The most important consequence of this mechanism is that it allows pervasive fluid flow through an initially low permeability rock and the transformation of one mineral assemblage to another [3]. A further aspect of this mechanism is the fact that within micropores a fluid can maintain a higher supersaturation than in a free fluid, and furthermore, the rate of dissolution of the parent phase will define a rate of change of supersaturation in the pores at the migrating interface. These two factors define the threshold supersaturation at which nucleation of the product phase takes place [4]. Taken together with the fact that the fluid composition within the porous parent phase will evolve in time depending on the mass transport through the interconnected porosity, modelling such an interface-coupled dissolution-precipitation process has proven to be a challenge.

[1] Pollok *et al.* (2011) *Am.J.Sci.* **311**, 211-236. [2] Putnis (2009) *Rev.Min.Geochem.* **70**, 47-85 [3] Putnis & Austrheim (2010) *Geofluids*, **10**, 254-269 [4] Prieto *et al.* (1994) *Journ.Cryst.Growth* **142**, 225-235.