ICG2022-449, updated on 06 Jun 2023
https://doi.org/10.5194/icg2022-449
10th International Conference on Geomorphology

Calcite cementation as a result of subglacial processes - the Saalian ice-sheet case study

Barbara Woronko[1], Karolina Ulbin[1], Katarzyna Skolasińska[2], Joanna Mirosław-Grabowska[3], Małgorzata Pisarska-Jamroży[2], Martyna Górska[2], and Karina Apolinarska[2]

[1]University of Warsaw, Faculty of Geology, Żwirki I Wigury 93, 02-089 Warsaw

[2]Adam Mickiewicz University, Institute of Geology, B. Krygowskiego 12, Poznań, 61-680, Poland

[3]Institute of Geological Sciences, Polish Academy of Sciences, Twarda 51/55, 00-818 Warszawa

Calcite cements are found within the glaciotectonically-deformed coarse-grained glaciofluvial sediments of the Saalian age (MIS 6) at the Koczery site (E Poland). Their sedimentation was controlled by the occurrence of permafrost (Mleczak et al., 2021). Under these conditions, aggradation rate of a glaciomarginal fan was high, and freezing of freshly-deposited sediments was relatively quick. Advancing ice sheet deformed these frozen glaciofluvial sediment in its foreland, creating single faults along with gently and tight folds. These deformed sediments were covered with a subglacial till creating a dome-like shaped landforms reassembling a Cupola hill. This calcite-cemented conglomerate occupies the uppermost part of coarse-grained glaciofluvial sediments. Its thickness ranges from 0.02–0.05 m up to 0.70 m and depends on the inter-limb angle of folds. The higher the inter-limb angle of folds, the thicker the conglomerate. Its greatest thickness is generally recorded on the lee side of major bed obstacles, i.e. glaciotectonically-deformed folds, in this case.

Precipitation of calcite within the glaciotectonically-deformed glaciofluvial sediments resulted from a progressive freezing of the basal water film that occurred on the side site of deformed structures. The water froze due to the drop in water pressure on the lee site of folds, which in turn led to the precipitation of calcite. The results of oxygen and carbon stable isotope studies ($\delta^{18}O$, $\delta^{13}C$) indicate limestone clasts embedded in the glaciofluvial deposits as the source of carbonates involved in the cementation process ($\delta^{18}O$ from -6 to -3‰ V-PDB, $\delta^{13}C$ – from -1.4 to +0.9‰ V-PDB). Two types of calcite cements were recognized in the studied conglomerate. Each of them is thought to be a record of different basal conditions during the ice-sheet advance. The precipitation of sparite cement took place during the early stages of freezing under open-system conditions (i.e. continuous flow of water within the film). Micrite cement which overlies the sparite one was precipitated during the final freezing under closed-system conditions (i.e. water flow in the film is dominated by locally produced water involved in the regelation sliding proces; Sharp et al., 1990). Moreover, it is known that micrite precipitates from water which is more supersaturated with respect to calcite than that from which sparite precipitates.

A thin (up to 1 mm thick) manganese-rich layer was registered between the layers of sparite and micrite cements. The precipitation of calcite is characterized by $\delta^{18}O$ and $\delta^{13}C$ values ranging from -6.9 up to -6.2‰ (V-PDB) and from -9.0 up to -5.5‰ (V-PDB), respectively. No significant differences in the isotope notation between micrite and sparite were observed, which clearly indicates similar parameters of the host water.

Mleczak, M., Woronko, B., Pisarska-Jamroży, M., Bujak, Ł., 2021. Permafrost as the main factor controlling the fluvial sedimentation style on glaciomarginal fans. Sedimentary Geology. 422, 105971. https://doi.org/10.1016/j.sedgeo.2021.105971

Sharp M., Tison J.L., Fierens G., 1990. Geochemistry of Subglacial Calcites: Implications for the Hydrology of the Basal Water Film. Arctic and Alpine Research, 22, 2, 141-152.