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Hyaloclastite formation during the effusion of the first lava flows of Siberian traps into a shallow freshwater basin

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Hyaloclastites have long been described within numerous volcanoclastic sequences in the Siberian Traps Large Igneous Province. They are typical for the southern and central parts of the Tunguska basin, and we inspected them in 2004–2010. In recent years, we have focused our attention on the northwestern region of the Tunguska basin (Norilsk area) with a volumetric manifestation of basaltic lava flows. We have completed fieldwork in this region from 2006 to 2019, with a recent focus on the understanding of the emplacement environments for the lowermost lava flow erupted directly on the end-Permian boggy surface. We studied pillow basalt at the basal part of the lowermost lava flow in the Norilsk region (Ivakininskaya Formation). In the upper part of this pillow basalt horizon, hyaloclastite is very common, and at the basal part, several tree trunks occur. The hyaloclastite includes black equant angular clasts and rusty red matrix and easily recognize at any outcrops. We studied hyaloclastite with optical microscopy and SEM-EDS. Black clasts composed of sideromelane cracked and altered to palagonite. Sideromelane fragments include crystals of olivine (Fo70), plagioclase (An63–70), and likely OPx altered to chlorite. Sideromelane glass has a basalt composition with elevated P₂O₅, CaO, and decreased amount of MgO and minor halogens (F, Cl). Some sideromelane clasts bear round inclusions (blobs) entirely infill with dolomite, siderite, and calcite. Every single carbonate inclusion has a specific structure and minerals infill.

We interpret these hyaloclastite rocks formations with carbonate inclusions as a result of lava flow effusion onto the shallow freshwater basin or boggy surface. Water and organic-rich sediments transferred with an explosion to steam and carbon dioxide gas, and this gas mixture was formed a hyaloclastite horizon at the basal part of a lava flow. We suppose that these sideromelane clasts with carbonate blobs are additional evidence of greenhouse gas generation during the early stage of the Siberian Traps lavas eruption.