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

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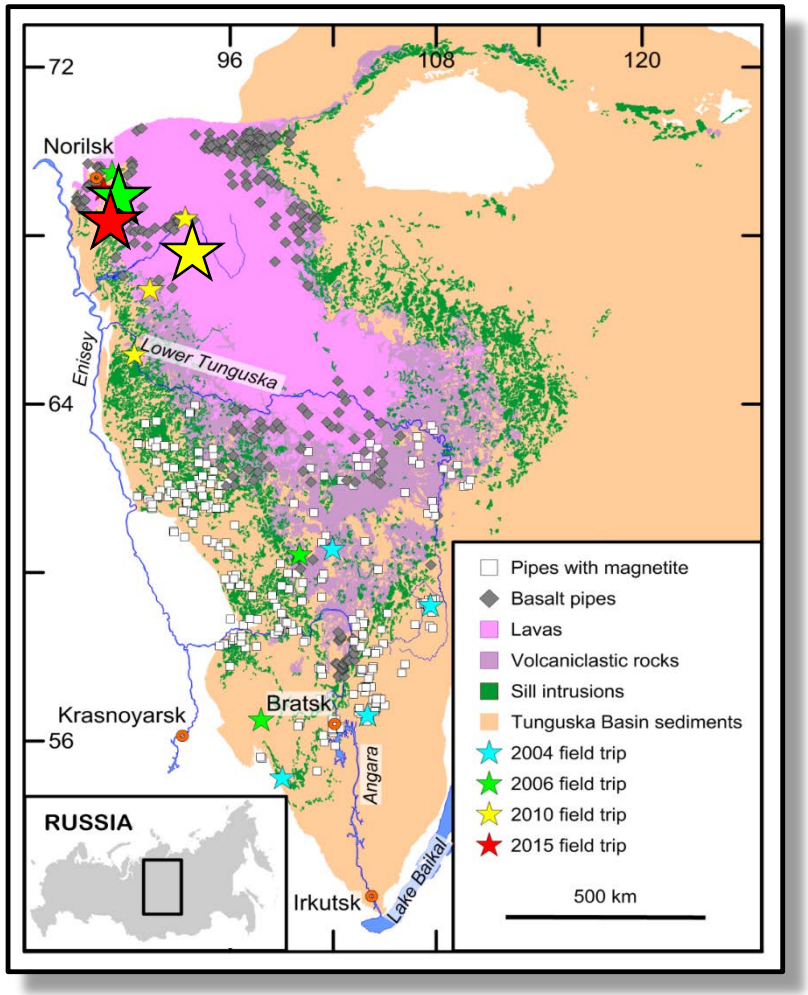
# Hyaloclastite sites




- Hyaloclastites have long been described within numerous volcaniclastic sequences in the Siberian Traps Large Igneous Province. We inspected some of these sites in 2004-2010 and last decade we focused on NW region of the Tunguska basin (Norilsk area, see below) with a volumetric manifestation of basaltic lava flows (bold stars on the map show the hyaloclastite sites visited from 2006 to 2019)

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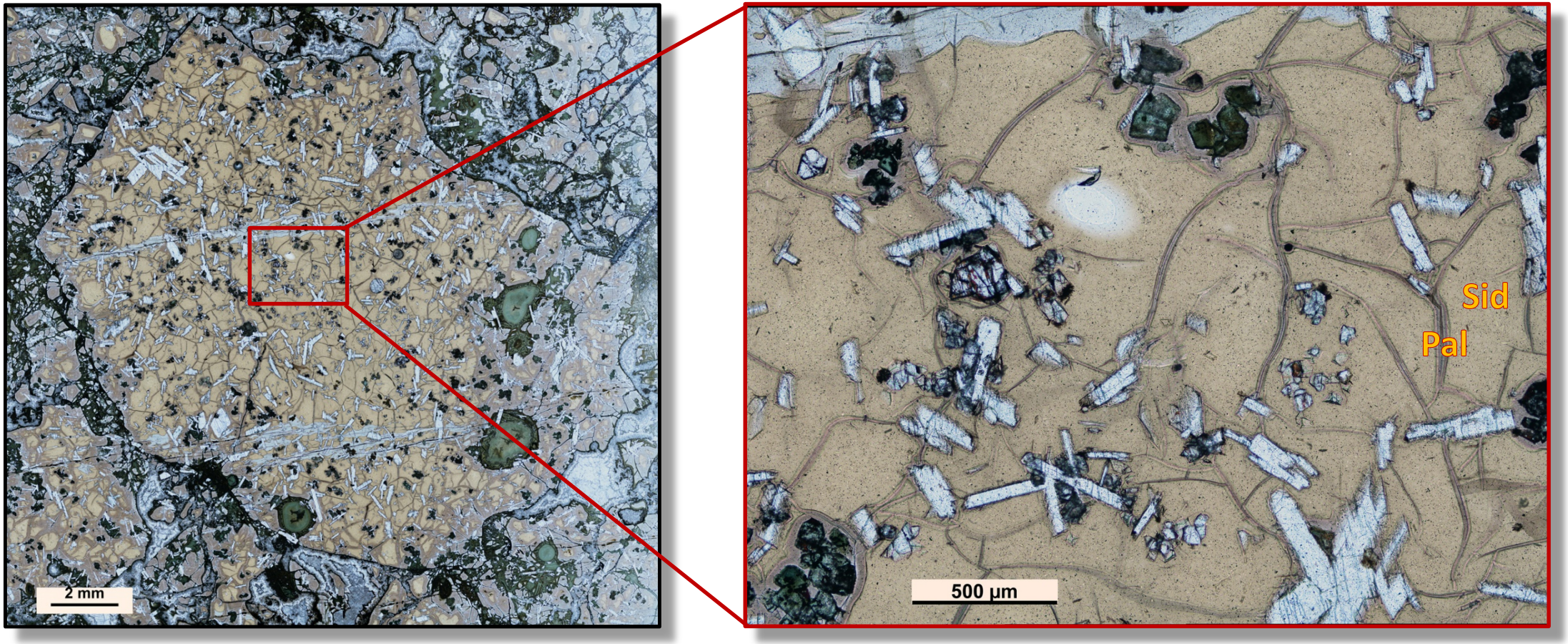
# Hyaloclastite horizon


- Typical for the southern and central parts of the Tunguska basin
- Occurs in the lowermost lava flow erupted directly on the end-Permian boggy surface in Norilsk area (NW part of the Tunguska basin)
- Found at upper part of pillow basalt located at the basal part of lava flow in the Norilsk region (Ivakinskaya Formation)
- Hyaloclastite includes black equant angular clasts and rusty red matrix

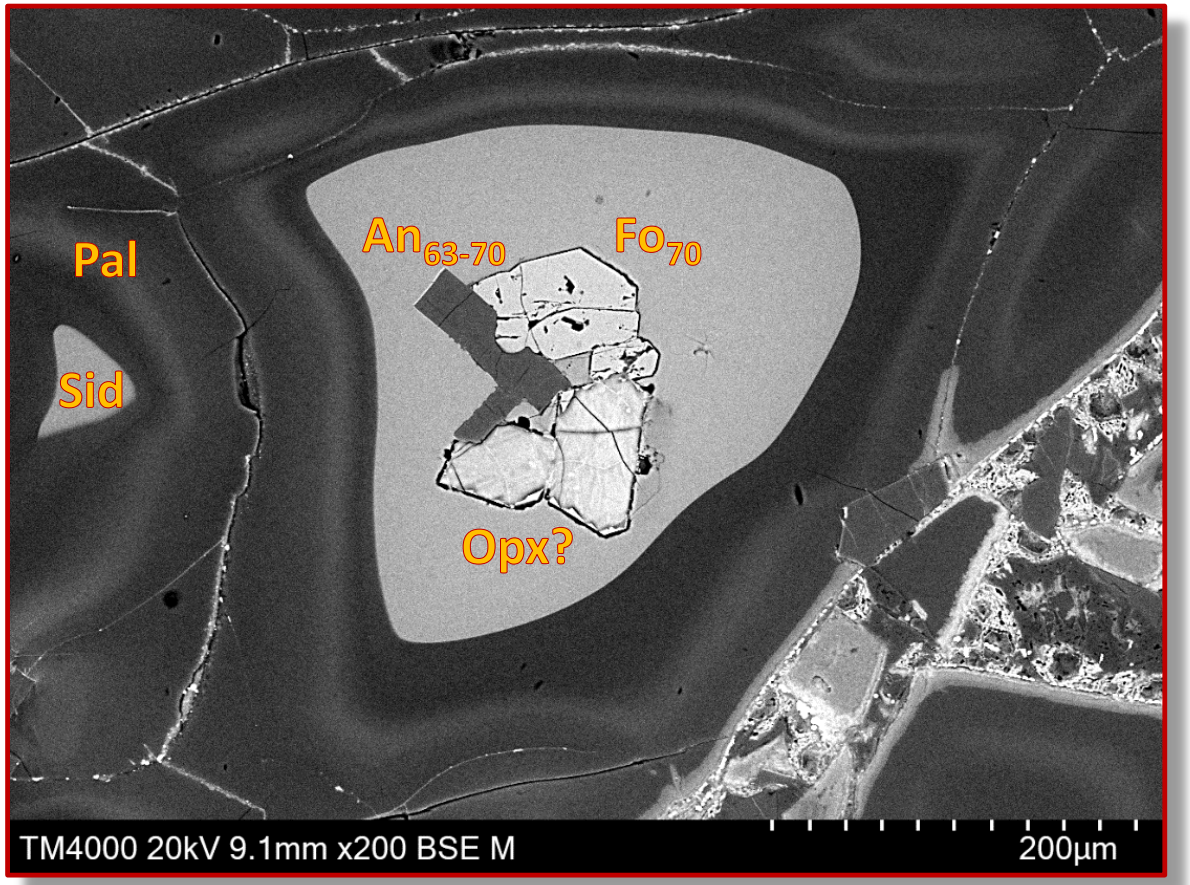
# Hyaloclastite composition

- Black clasts composed of sideromelane (Sid) cracked and altered to palagonite (Pal)



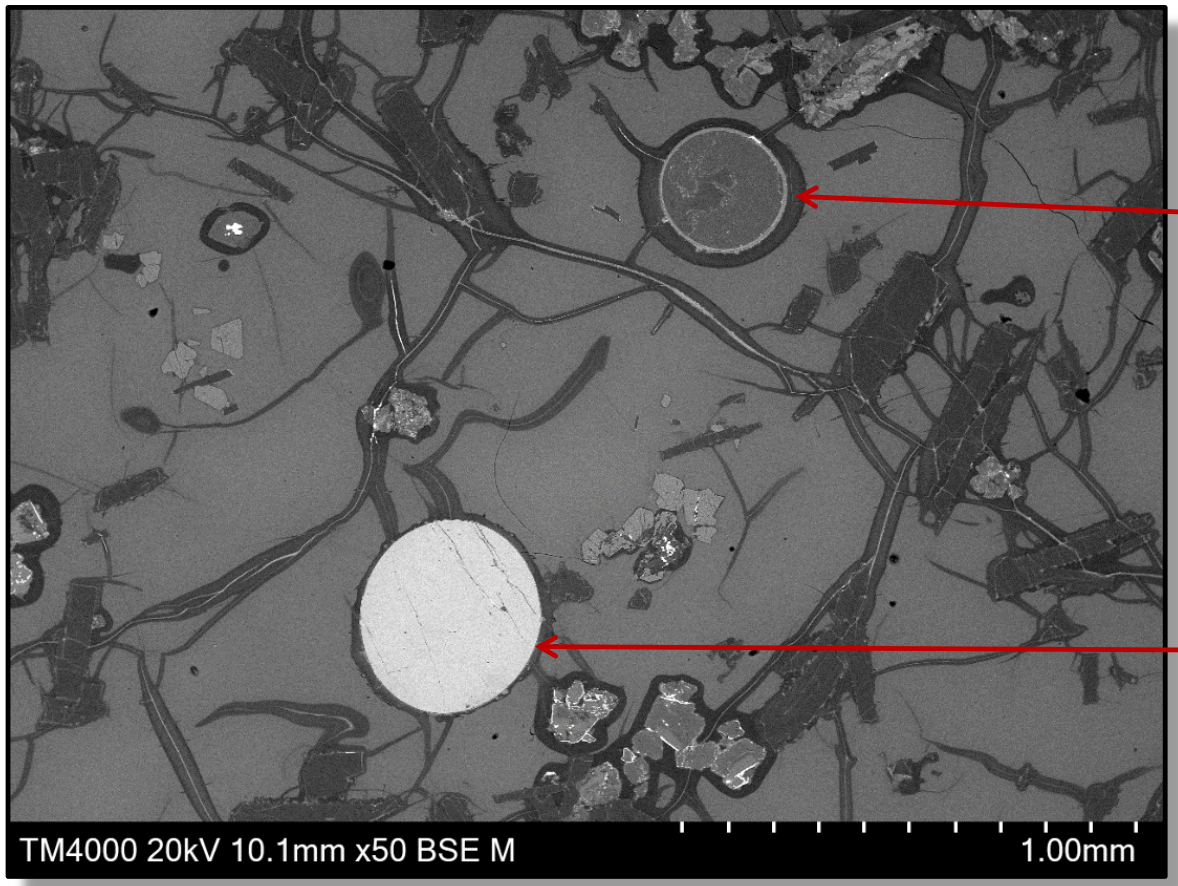
# Hyaloclastite composition

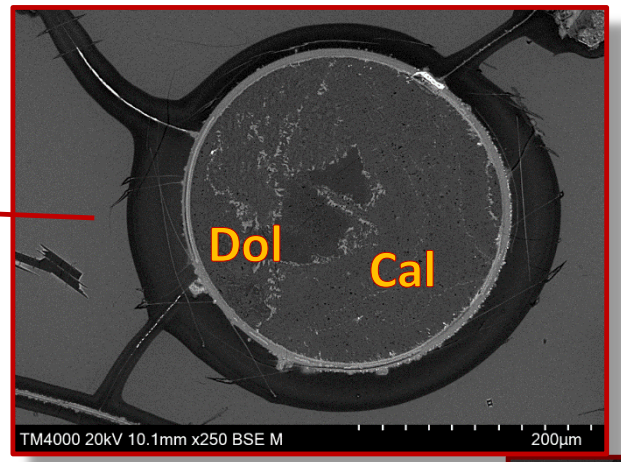
- Sideromelane fragments include crystals of olivine (Fo70), plagioclase (An63-70), and likely OPx altered to chlorite

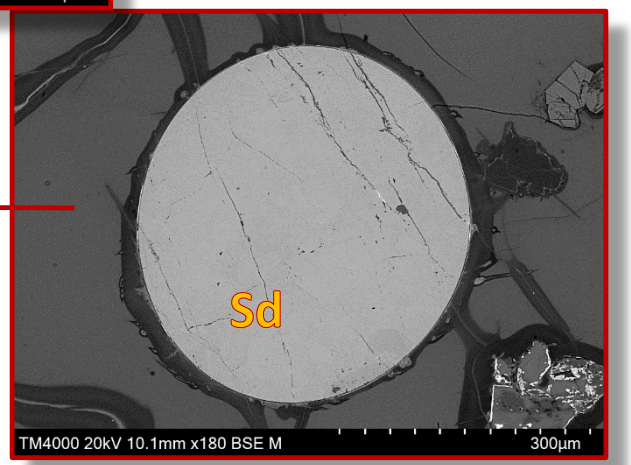


# Carbonate blobs in Sideromelane

- Some sideromelane clasts bear round inclusions (blobs) entirely infill with dolomite (Dol), siderite (Sd), and calcite (Cal)

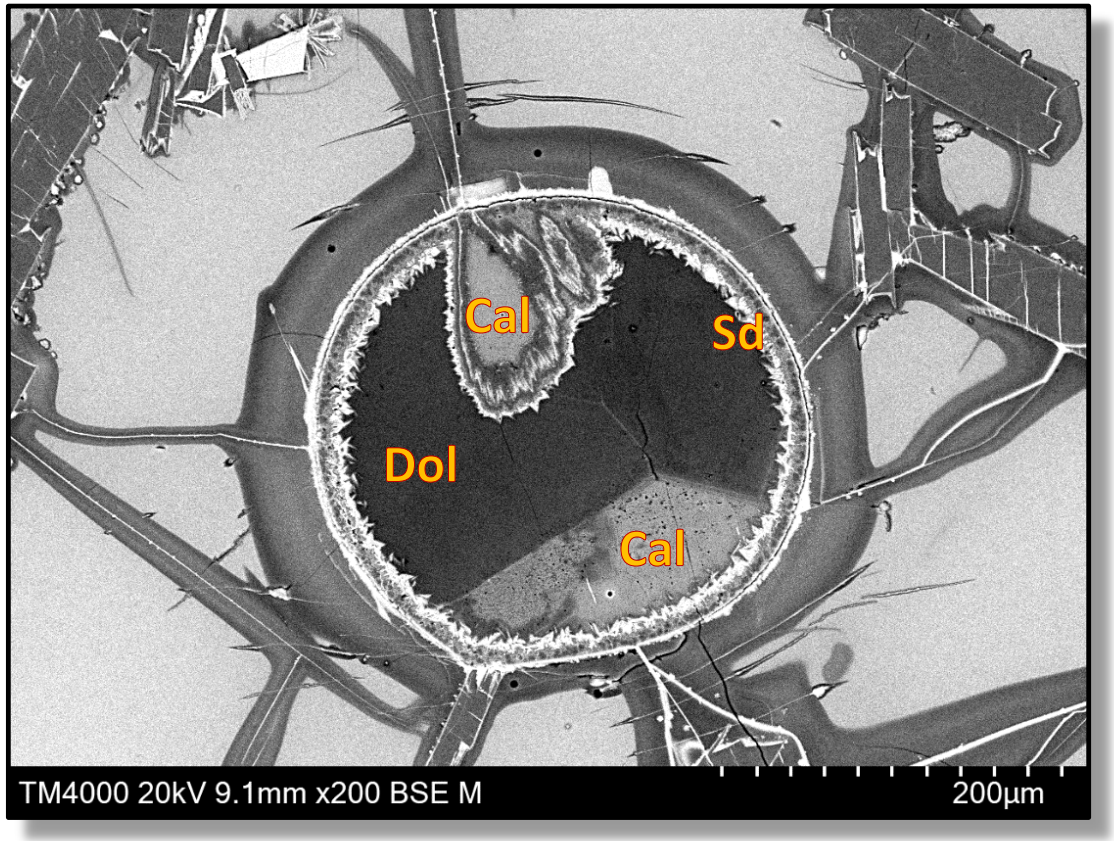


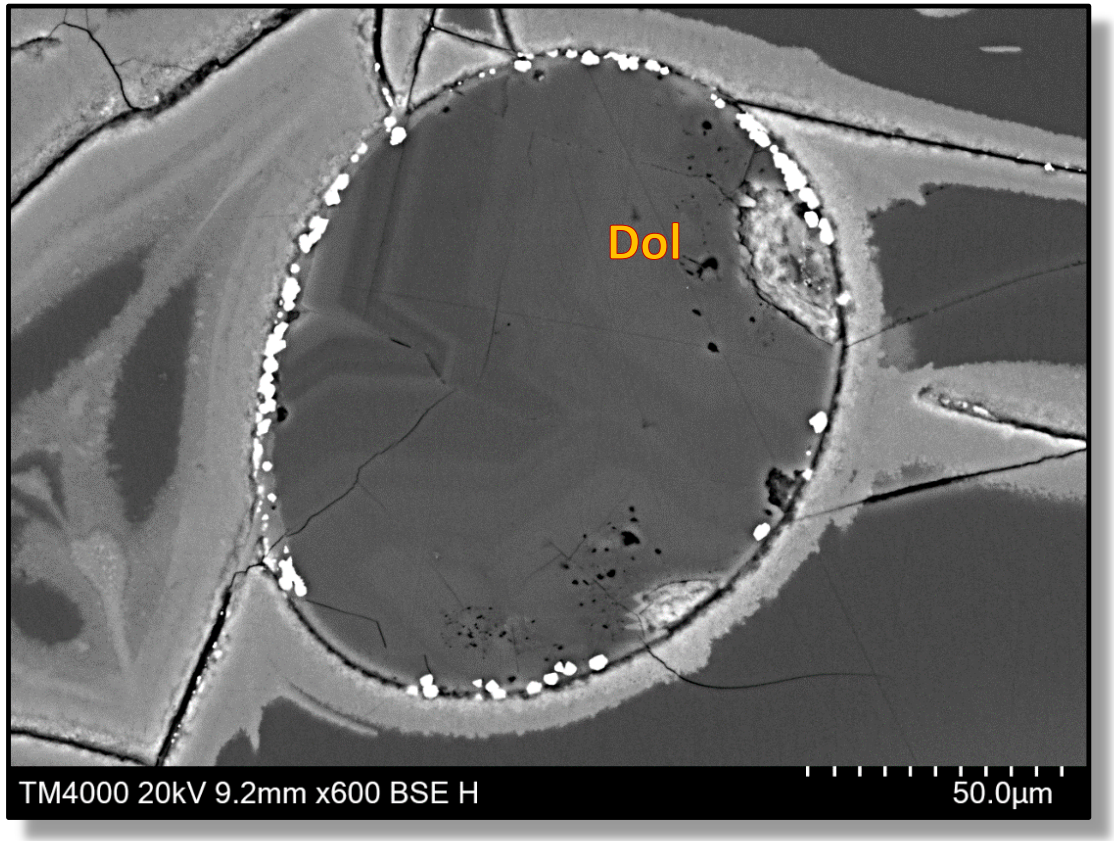



# Carbonate blobs in sideromelane

- Every single carbonate inclusion has a specific structure and minerals infill



# Conclusions

- We interpret the hyaloclastite rocks with carbonate inclusions to be formed as a result of lava flowing into shallow freshwater lakes or onto a boggy surface.
- Water and organic-rich sediments were transformed to steam and carbon dioxide gas, and this gas mixture lead to rapid lava cooling and quenching, forming a hyaloclastite horizon in the basal part of the lava flow.
- We argue that the sideromelane clasts with carbonate blobs are additional evidence of greenhouse gas generation during the early stage of the Siberian Traps lava eruption.