Fluid-deposited graphite in pseudotachylytes: Implication for fault degassing and precipitation by redox change

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Redox state in fault zones is key to understanding the behavior of fluids related to seismic activity [1]. However, the origin, timing, quantity and composition of fluids released during seismogenic faults and its experimental analogues are very limited.

In this study, we focused on the occurrence of graphite and sulfide minerals in pseudotachylyte matrix to understand the redox state and fluid speciation. The pseudotachylytes belonging to Hidaka metamorphic belt were sampled from the occurences as reported by Nakamura et al. (2015) [2]. They can be mainly grouped into two types (Pst I and Pst II) based on the occurrences, microtextures and mineral assemblages of lithic fragments (ϕ) and secondary minerals. Pst I has higher fraction of lithic fragments (ϕ: 20–52 vol. %) and Kfs and pyrrhotite (N[FeS] = 0.92–0.94), suggesting relatively oxidized pseudotachylyte melt based on the P-T-fO_2-fS_2 phase diagram. On the other hand, Pst II represents low volume fraction of lithic fragments (ϕ: 2–15 vol. %), biotite microlite, plagioclase spherulites, and a lot of vesicles. In particular, the fluid deposited graphite with hydrous minerals are observed in Pst II matrix (delta13C = -21.86 +/- 2.2 ‰, n = 16), shifting the carbon isotope values of +2 to 3‰ from host metamorphic graphite (delta13C = -24.86 +/- 0.6‰, n = 13). This imply that the Pst II melt was at relatively low fO_2 conditions due to the dissolution of metamorphic graphite (□FMQ -2 and -2.4).

Our data suggest that degassing or precipitation processes of graphite and pyrrohtite in pseudotachylyte melt are driven by the redox state. In particular, selective melting as a fuction of melting temperature results in the formation of oxidized mafic melt and reduced felsic melt in micrometer sclale pseudotachylyte veins. These two compositionally different melts mingle each other to form "plagioclase-mantled K-feldspar ovoid" textures. In addition, our data suggest the release of large amount of carbon from “biogenic carbon” included in the sediments by fricitional melting in fault zones.

[1] O’hara and Huggins, 2005. *CMP*, **148**, 602-614. [2] Nakamura et al. 2015. *JSG*. **72**, 142-161.