Spilitization of Early-Permian volcanics from Głuszyca Górna (the Intra-Sudetic Basin, Poland) - constraints from chlorite thermometry coupled with apatite fission-track dating (AFT)

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1. Introduction

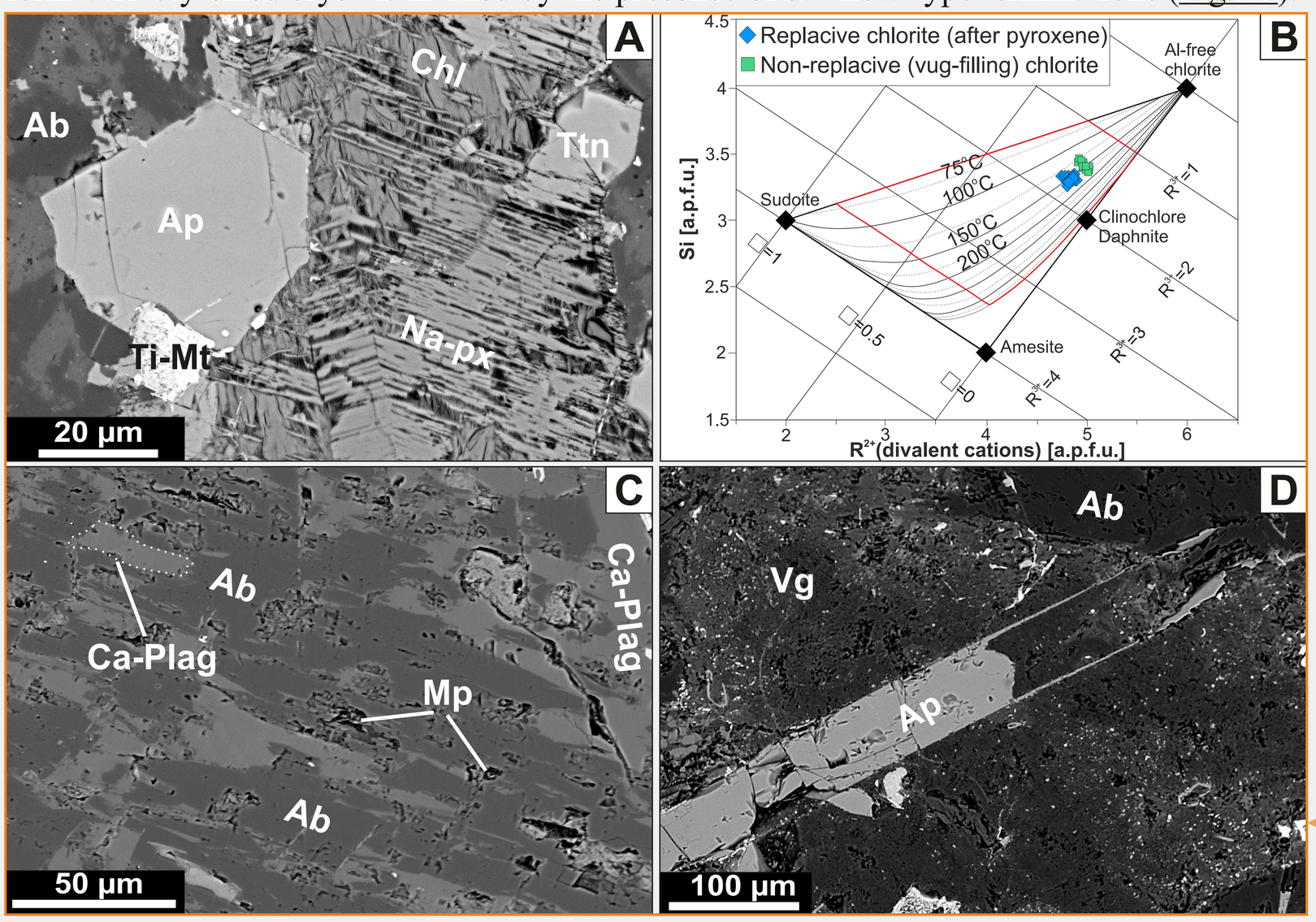
Spilites (or spilitic rocks) represent low-grade metamorphic rocks that form via: (1) water-rock interactions during submarine effusions, (2) burial metmorphism, (3) post/late-magmatic auto-hydrothermal alterations, (4) mixing of magma with hot brines (Amstutz, 1979). They are chiefly composed of albitized plagioclases, accompanied by variable amounts of chlorite, epidote, and carbonate minerals. The aim of the following study was to determine whether combined chlorite thermometry and apatite fission-track dating (AFT) could be used to establish the timing of secondary fluid flow, which has been responsible for regional-scale spilitization developed in basaltic rocks from the Intra-Sudetic Basin. Our considerations are based on the mineralogical-geochemical data obtained for trachyandesites found in closed Głuszyca quarry.

2. Geological settings

The Intra-Sudetic basin represents a Late-Paleozoic intramontane trough filled with volcanogenic-sedimentary succession. Volcanic rocks from Głuszyca (Fig.1) belong to trachyandesites of Rybnica Leśna Volcanic Association (Awdankiewicz, 1999). They occur as shallow-level subvolcanic (laccolith-type) body of ca. 100m in depth and 300m in length. The assemblage of Głuszyca trachyandesites was linked to the post-collisional (continental), extension-related magmatic activity developed within the Intra-Sudetic Basin during the climax of Variscan Orogeny.

3. Petrography and chlorite thermometry

The samples contain both Na-rich and Ca-rich pyroxenes. The former has been ubiquitously altered to either massive or fibrous, Mg-rich chlorites (Fig.2A). Chlorite were also found as vug-filling non-replacive crystals associated with celadonite mica. Semi-empirical chlorite thermometer (Fig.2B) indicate that chloritization could be a low-temperature process (ca. 125 -175°C). Volcanics from Głuszyca are rich in secondary albite developed as elongated patches disseminated through the interior of the host primary plagioclase (Fig.2C). Accessory apatite form variably-sized crystals marked by the presence of swallow-type terminations (Fig.2D).



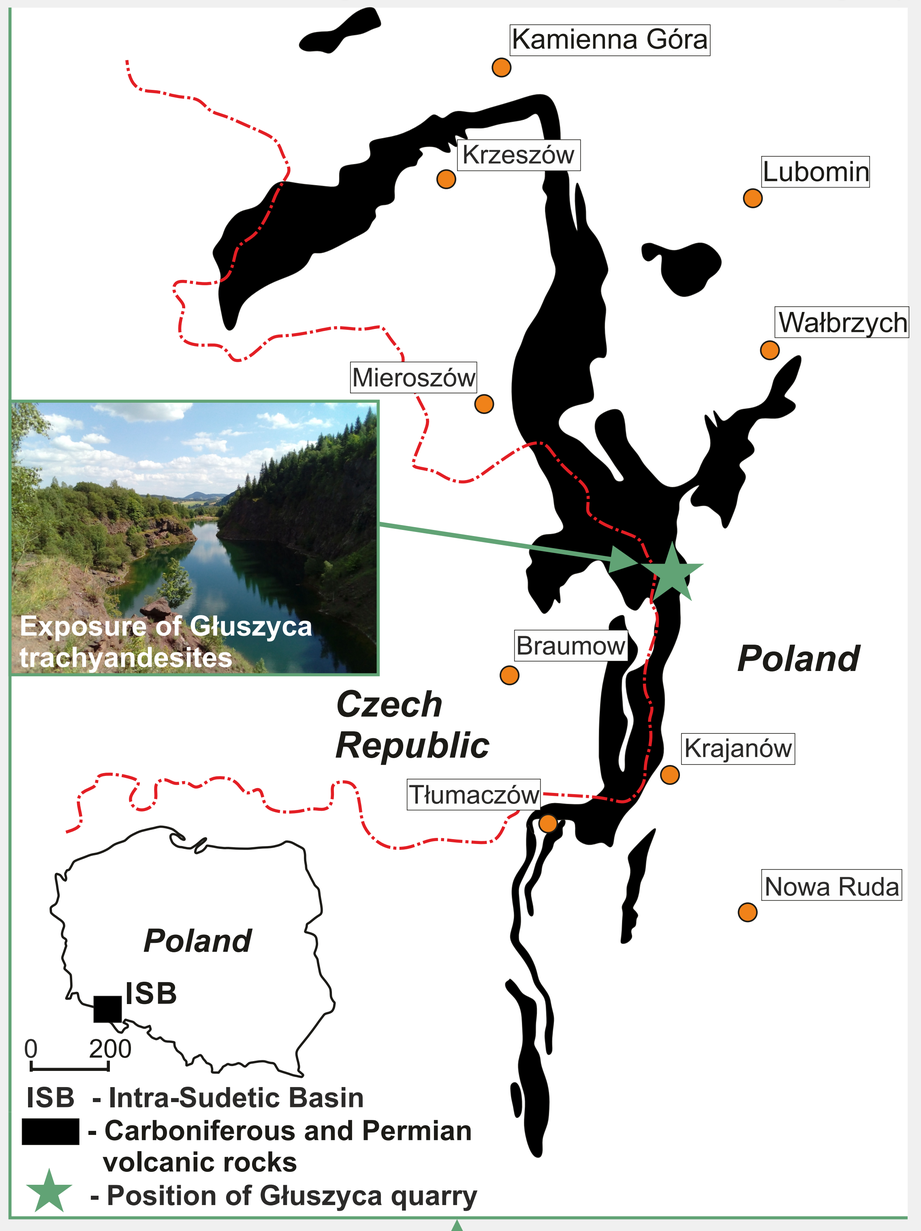


Fig. 1. Distribution of Carboniferous and Permian volcanics in the ISB

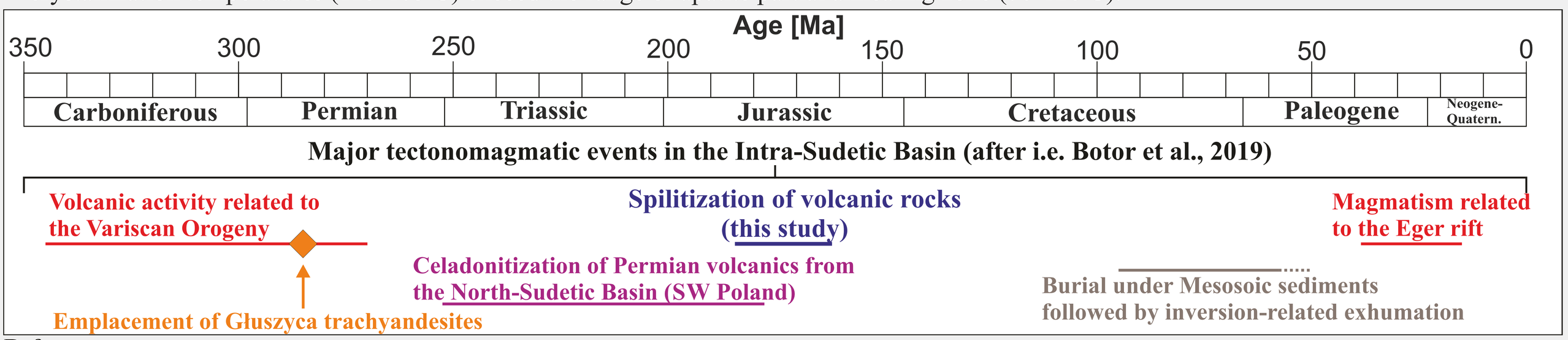
Fig. 2. (A) Partially chloritized Na-rich pyroxene accomapnied by apatite (Ap) and secondary titanite (Ttn); (B) Chlorite crystallization temp. assesed using T-R^{2+}-Si plot (after: Bourdelle and Cathlineau, 2005); (C) Partial breakdown of Ca-rich plagioclase (Plag) into secondary pure albite (Ab); note that alteration is accompanied by the emergence of micropores typical of dissolution-reprecipitation mechanism; (D) Swallow -tailed (H-shaped) apatite embedded within volcanic glass (Vg)

4. Apatite fission-track dating (AFT)

AFT results of variably spilitized trachyandesites are in the range between 181 Ma (partial albitization and chloritization) and 162 Ma (pervasive albitization and chloritization). These ages are younger than the igneous emplacement of magmatic body from Głuszyca (ca. 290 Ma). Regarding the fact that apatite closure temp. is between 70-120°C, the rocks could undergo a thermal reset following the emplacement of magmatic body.

5. Conclusions

1. Swallow-tailed morphology of apatite reflects its rapid-growth formation conditions, related to the final stages of magma eruption;
2. Breakdown of Na-rich pyroxenes could provide necessary amounts of Na^+ for later albitization of primary plagioclases;
3. The obtained AFT ages (182-161 Ma) have possibly preserved the record of - spilitization-related - partial reheating of the rocks, since chlorite crystallization temperatures (125-175°C) exceed the range of apatite partial annealing zone (70-120°C).



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