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Halogens, B and Li in lawsonite blueschists

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Blueschists from the Tavsanli zone in NW Turkey represent the northern margin of the Anatolide-Tauride Block subducted to 80 km depth during the late Cretaceous [1]. They contain Na-amphibole and lawsonite, with minor phengite, omphacitic pyroxene, and quartz. Lawsonite laths (<5 mm) are surrounded by fibrous aggregates of blue Na amphibole, some of which is retrogressed to chlorite. Bulk rocks contain high MgO (4.7-13 wt%), FeO_{total} (8.2-11 wt%) and TiO_2 (0.46-3.1 wt%), confirming a basaltic protolith. All samples are enriched in fluid-mobile elements (Pb, Sb, Sr, Li), and most are enriched in Cs, Rb and Ba. High Na_2O (<3.1 wt%) are consistent with sea-floor alteration prior to subduction, yet bulk pyrohydrolysis data shows low Cl (8-56 ppm) and Br (0.11-0.47 ppm) relative to seawater. They contain higher I (0.12-1.37 ppm) and F (120-955 ppm) than MORB.

Sodic amphiboles are of the crossite variety with high Fe_2O_3 (<17 wt%). Phengite (3.4-3.9 Si p.f.u.) also has relatively high Fe_2O_3 (<5.3 wt%). Lawsonite contains <2.3 wt% FeO_{total} (mostly Fe^{2+}), high Sr (avg. 1512 ppm), Y (avg. 70 ppm) and Ce (avg. 1090 ppm) compared to phengite and amphibole, but low Li (<0.19 ppm) and B (<5.4 ppm). Lithium preferentially partitions into Na-amphibole with K_D (Li) = 2.6-12, and B into phengite (K_D (B) = 7.2-44). Fluorine partitioning follows phengite>lawsonite>Na-amphibole, with average contents of 482, 413 and 257 ppm, respectively. On average, lawsonite contains low Cl (27 ppm) relative to phengite (56 ppm) and Na-amphibole (59 ppm). SIMS analysis of F and Cl for phengite and amphibole used amphibole calibration standards.

This study shows that hydrous minerals lose Cl, but retain F during subduction. Since Na amphibole, lawsonite and phengite are stable to depths of ~90 km, ~280 km and > 300 km, respectively [2], relatively high contents of F in lawsonite, and F and B in phengite suggest their transport by these minerals to the deep upper mantle.

[1] Sherlock et al. (1999) *Contrib. Mineral Petr.* ***137***, 46-58.
[2] Schmidt & Poli (1998) *Earth Planet Sci. Lett.* ***163***, 361-379.