Isotopic evidence for Cretaceous- Paleocene upwelling from archaic crust in Snowbird-type deposits.

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Introduction

Snowbird deposits are a series of small hydrothermal, quartz-carbonate veins that intrude Belt metasediments on a strike line extending NW-SE from the Coeur d'Alene Mining District along the Idaho-Montana border toward the Idaho Batholith (Fig. 1). Early carbonates and quartz are Mesoproterozoic (Ramos and Rosenberg, 2012). Purple(P) and green(G) fluorite occur in Snowbird-type deposits (Rosenberg and Wilkie, 2015). Masses of similar fluorite have also been reported in the Bitterroot lobe of the Idaho Batholith (Foord et. al., 1993) at Crystal Mountain (Fig.1).

Age and Origin

U-bearing xenotimes in calcite closely associated with fluorite at Wilson Gulch and the Swallow deposit (Fig. 1) yield concordia ages of late Cretaceous to early Paleocene (Figs. 2 and 3). Pb 207/204 and 206/204 ratios in closely associated, xenotime-free fluorites lie along a straight line (Fig 4) which corresponds to an age of 1341 ± 75 Ma (MSWD = 492). 207/204 - 206/204 ratios in fluorite from the Idaho Batholith (Table 1, DB-F(G) also lie on this line which is thought to represent upwelling of fluids from underlying Archiozoic to Paleoproterozoic crust. Proterozoic upwelling (1523 ± 41 Ma; Ramos and Rosenberg, 2012) was apparently renewed in late Cretaceous to early Paleocene times. U was scavenged by xenotime during crystallization from these fluids, thus setting the xenotime clock while leaving associated fluorites essentially U-free (Table 2). Xenotime is absent at DB-F(G) and, therefore, U is higher in this fluorite sample (Table 2).

For example, purple fluorite from Wilson Gulch north of the Snowbird deposit (Fig. 1) with a xenotime concordia age of ≈ 72 Ma(Fig. 2) has 206/204-207/204 ratios of 34.280 and 16.969 respectively (Table 1) while green fluorite from the Swallow deposit, south of the Snowbird deposit (Fig. 1), with a xenotime concordia age of ≈ 61.5 Ma (Fig. 3) has 206/204, 207/204 ratios of 24.117 and 16.047 respectively (Table 1).

Fig. 1. Map showing locations of principal fluorite localities (Snowbird-type and Crystal Mountain in the Bitterroot lobe of the Idaho Batholith).

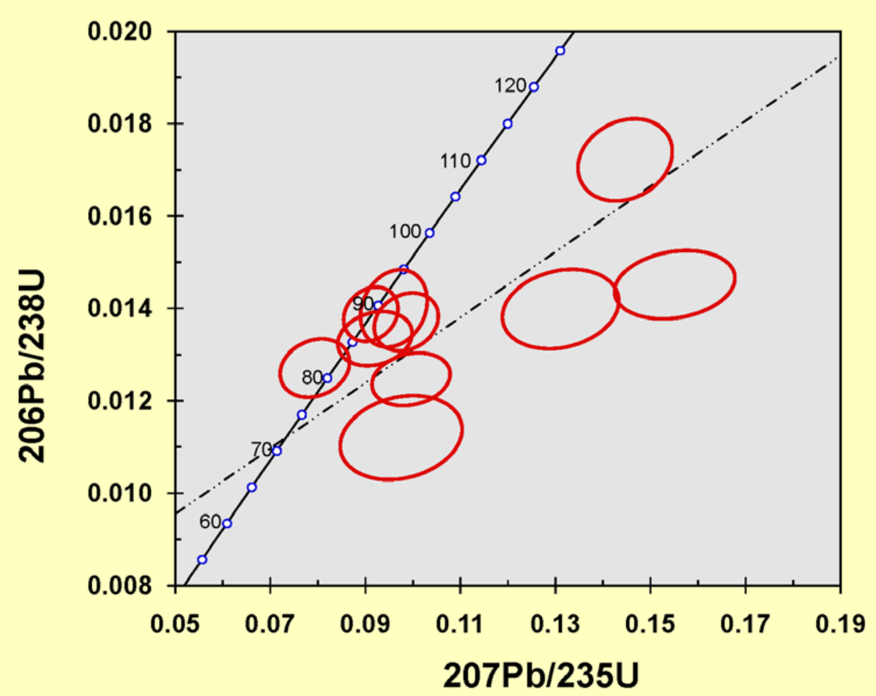

Fig. 2. Concordia diagram for xenotime in calcite associated with purple fluorite, Wilson Gulch deposit. Age 72 Ma ± 27 (MSWD = 13). Data-point error ellipses are 2σ.

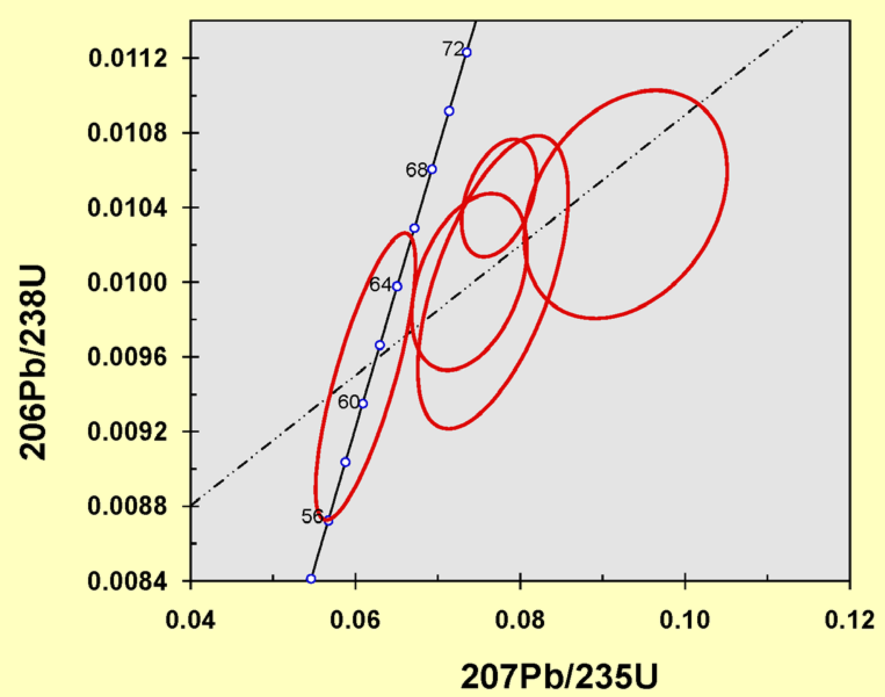

Fig. 3. Concordia diagram for xenotime in calcite associated with green fluorite, Swallow deposit. Age 61.5 Ma ± 5.1 Ma (MSWD = 2.2). Data-point error ellipses are 2σ.

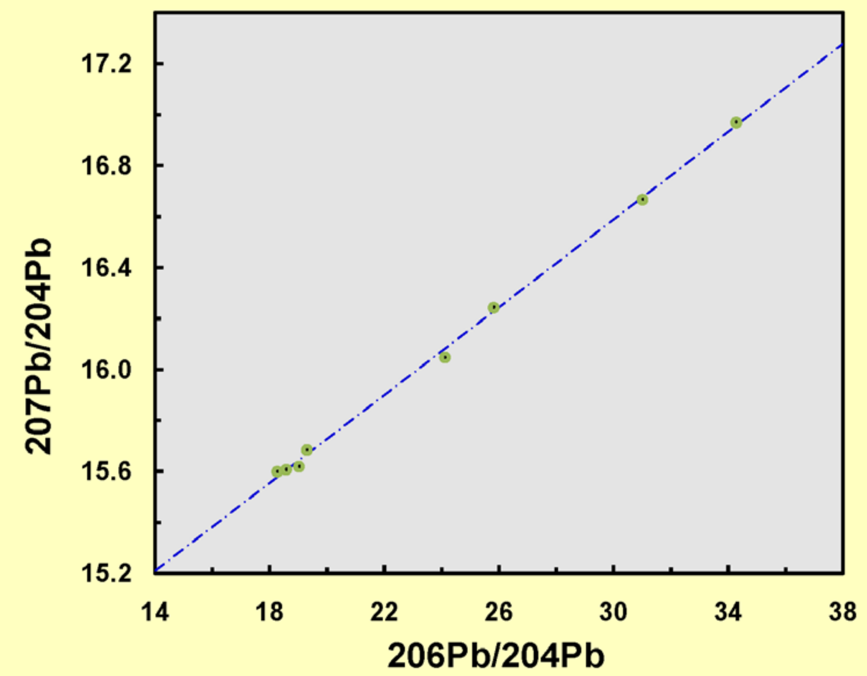

Fig. 4. 206 Pb/204 vs. Pb-207Pb/204Pb diagram calculated using Isoplot 3. Age = 1341 ± 75 Ma (MSWD = 492). Data-point error ellipses are 2σ.

Table 1. Pb isotope data.

Location/Deposit	Sample*	Pb 206/204	Pb 207/204
Spar	SP-F(P)	25.813	16.243
Lime Gulch	LG-F(P)	19.298	15.684
Crystal Mountain	DB-F(G)	18.578	15.607
Snowbird	SB-106F(P)	18.268	15.599
Snowbird	SB-138F(P)	31.005	16.666
Wilson Gulch	WG-F(P)	34.28	16.969
Swallow	SW-C F(P)	19.019	15.619
Swallow	SW-C F(G)	24.117	16.047

* (P) purple fluorite, (G) green fluorite

Table 2. U data and initial Sr isotope ratios.

Location/Deposit	Sample *	U ppm	Initial Sr isotope ratios
Spar	SP-F(P)	0.00	0.7980
Lime Gulch	LG-F(P)	0.00	0.9049
Crystal Mountain	DB-F(G)	0.85	0.8125
Snowbird	SB-106F(P)	0.01	
Snowbird	SB-128F(P)	0.00	0.8487
Snowbird	SB-138F(P)	0.03	0.8125
Wilson Gulch	WG-F(P)	0.04	0.8689
Swallow	SW-C F(P)	0.00	
Swallow	SW-C F(G)	0.01	

* (P) purple fluorite, (G) green fluorite

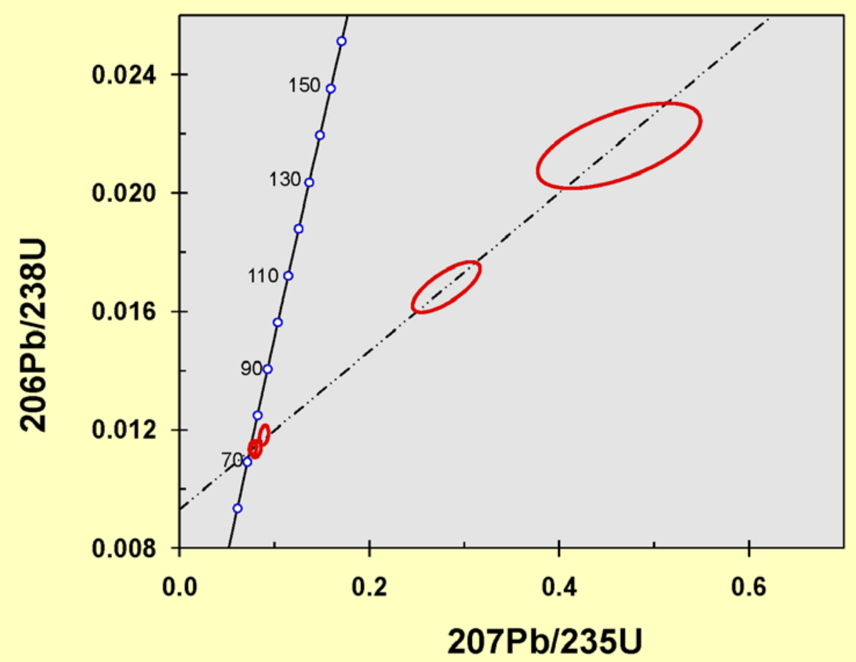

Fig. 5. Concordia diagram for xenotime in calcite associated with purple fluorite, Snowbird deposit (SB-135). Age 72 Ma ± 1Ma (MSWD = 0.57). Data-point error ellipses are 2σ.

The concordia age of purple fluorite from the Snowbird deposit is 72 ± 1 Ma (Fig. 5). Initial $^{87}Sr/^{86}Sr$ ratios of fluorites are ≥0.80 (Table 2) suggesting relatively recent emplacement from an archaic source. Early Cretaceous jasperoid veins have also been reported at the Sunshine Mine in the Coeur d'Alene District (Fig. 1) which may represent an earlier periods of Cretaceous remobilization (Zartman and Smith, 2009).

Conclusions

Mesoproterozoic upwelling of fluids from underlying Archean-Paleoproterozoic crust in the Pacific NW has been discussed recently by Ramos and Rosenberg (2012). The present study documents renewed upwelling in late Cretaceous to early Paleocene times, contemporaneous with faulting on the Lewis-Clark Line (Wallace et al., 1990) and intrusion of the Bitterroot lobe of the Idaho Batholith (Foster and Fanning, 1997; Fig. 1).

References

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Note: Sample numbers refer to map in Metz et al. (1971) Econ. Geol. , 80, 394-409.