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Short Communication

The possible significance of uncommon barium-rich mineral assemblages in sediment-hosted lead-zinc deposits

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Introduction

As every high school chemistry student knows, the solubility of barium sulfate is so low that this feature is used in the standard test for sulfate or barium. So, if seawater, with a typical sulfate content of 2650 ppm SO_4, should come in contact with a barium-bearing fluid there should be no doubt that the product of mixing will be barite. By far the majority of lead-zinc-barium deposits that are thought to be of exhalative origin do indeed contain their barium as barite (e.g. Meggen, Silvermines, Lady Lorretta). The barite normally forms a facies marginal to the sulfide body and is interpreted as representing the interface between the reducing, metal-depositing fluid and the oxidising seawater. The sulfur isotope signature of the barite thus almost always lies close to that of contemporaneous seawater. The ubiquitous availability of sulfate in ore depositional systems is further shown by the fact that (to my knowledge at least) all the barium in Mississippi Valley Type systems occurs as barite. However, there are a small number of deposits, all thought to be of exhalative origin, that form striking exceptions to this uniformity. It is probable that these deposits are telling us something of significance about their own environment of formation and also about exhalative deposits in general.

The deposits

Four main area are known where barium has accumulated in a non-sulfate phase. These are:

1. The Mirgalimsai deposit in the Karatau Range of the USSR.
2. The Aberfeldy and related deposits in the Dalradian of Scotland.
3. The Tom, Jason, Tea and Moose deposits in the Selwyn Basin of Canada.
4. The Rosh Pinah deposit of the Gariep Belt of Namibia.

Mirgalimsai

Mirgalimsai appears to be a large (mining began in 1942) lead-zinc-silver-barium deposit situated in a sequence of intracratonic Carboniferous limestones and dolomites overlying a red bed succession. Smirnov in his book on Russian ore deposits says the principle barium mineral is barytes, the amount of which varies from 0 up to 60–70%. Besides barytes, witherite, barytocalcite and barytocelestite occur in the deposit.

Tom (Large 1981)

The Tom deposit is a yet to be developed body of some 9 million tonnes (8.4% zinc, 8.6% lead, 84 g/t silver) in the U.Devonian-L.Carboniferous sediments on the eastern margin of the Selwyn Basin. Although barite is common, significant amounts of barium are present as celsian, witherite, barytocalcite, benstonite and, in the hangingwall shales away from the deposit, cymrite. Reconnaissance work by Large on the nearby Jason, Tea and Moose deposits also revealed some of these phases.

Aberfeldy (Coates et al., 1980)

In addition to a major barite body – the Foss deposit – the mineralisation at Aberfeldy consists of lead-zinc rich units and concentrations of quartz-celsian rock and micaceous schists with cymrite and hyalophane. The mineralisation is enclosed by the late Precambrian – early Paleozoic intracratonic Dalradian schists.

Rosh Pinah (Page and Watson, 1976)

Rosh Pinah is a discontinuous lens of several million tonnes of around 2% lead, 7% zinc, 58 g/t silver associated with a sequence of Lower Proterozoic sediments and volcanics in the Gariep Belt of Namibia. Norsethite, barite, benstonite, witherite, barytocalcite and celsian in various proportions make up a major gangue component of the orebodies, often in excess of 50%.

Lesser occurrences

Lippmann (1962) described benstonite from one of the bedded barite deposits of Arkansas. Norsethite and benstonite have been identified in the Langban exhalative manganese deposit (Sundius and Blix, 1966). Minor barium mica is present at Hilton.

Discussion

All the occurrences of non-baritic exhalative deposits can be interpreted as being in very restricted sedimentary environments. Thus I suggest that they have formed in basins, possibly of fresh or brackish water, in which the exhalation of copious quantities of barium could deplete the sulfate budget to the point that the stability field of other barium minerals could be entered. In doing so the dispersion of barium could exceed that normally achieved in an open marine setting and thus produce a more extensive marginal exhalite. Records in the literature to such strange barium rock types could be viewed as potential guides to a nearby exhalative centre. A word of caution should however, be sounded. I once interpreted a norsethite-acmite schist as a metamorphosed exhalite. Further work in the field revealed the rock to be a fennite. However, in intracratonic basinal settings the first interpretation should probably favour the exhalative hypothesis.

Mineral glossary

Norsethite:	$BaMg(CO_3)_2$
Benstonite:	$Ca_7Ba_6(CO_3)_{13}$
Barytocalcite:	$BaCa(CO_3)_2$
Celsian:	$B_aAl_2Si_2O_8$
Cymrite:	$B_aAl_2Si_2(O,OH)_8 \cdot H_2O$
Hyalophane:	$(K,Ba)Al(Si,Al)_3O_8$

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