VOLCANOGENIC MASSIVE SULPHIDE DEPOSITS OF CUBA

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Introduction

Although rich in natural resources and with a mining history dating back to the Spanish conquest, there have been few widely available reviews of Cuban mineral deposits. In this review we describe the tectonic setting of the Cuban VMS deposits and divide them into the conventional types of Cyprus, Kuroko and Besshi.

Geology of Cuba

The geological history of Cuba, at the western end of the Greater Antilles island arc, began with the the creation of oceanic crust in Jurassic time. The island arc was created when subduction, probably towards the north, began in Lower Cretaceous time and continued to mid-Eocene, when the island arc collided with the Bahamas Platform (Iturralde-Vinent, 1994). The collision created three main belts of rocks in Cuba. On the north side of the island the carbonate and evaporite continental facies of the Bahamas Platform dominate. These are overthrust by an Ophioite Belt, which is in turn overthrust by volcanic rocks of the Cretaceous and Paleogene island arcs (Fig. 1). A fourth, discontinuous belt, of Jurassic to Lower Cretaceous metamorphosed continental margin rocks, collectively named the Southwestern Terranes (Iturralde-Vinent, 1994), may have originated as part of the Yucatan Block to the west of Cuba, or as part of the South American continent. Post orogenic Latest Eocene to Recent sedimentary rocks represent about 60% of the present surface geology.

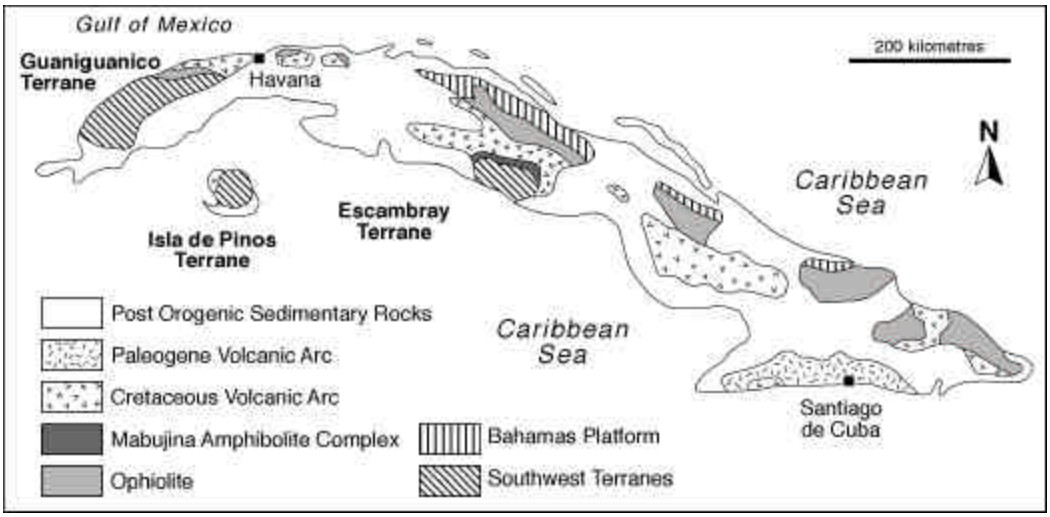

Figure 1. Geological map of Cuba showing the main structural belts.

Massive sulphide deposits that can be included in the VMS category are widespread throughout Cuba, but apart from El Cobre deposit in eastern Cuba, few have been mined successfully for their base metal content. The deposits occur in the Ophiolite Belt, the Southwestern Terranes, the lower part of the Cretaceous volcanic arc and the Paleogene volcanic arc, but are notably absent in the Upper Cretaceous volcanic arc (Fig. 2).

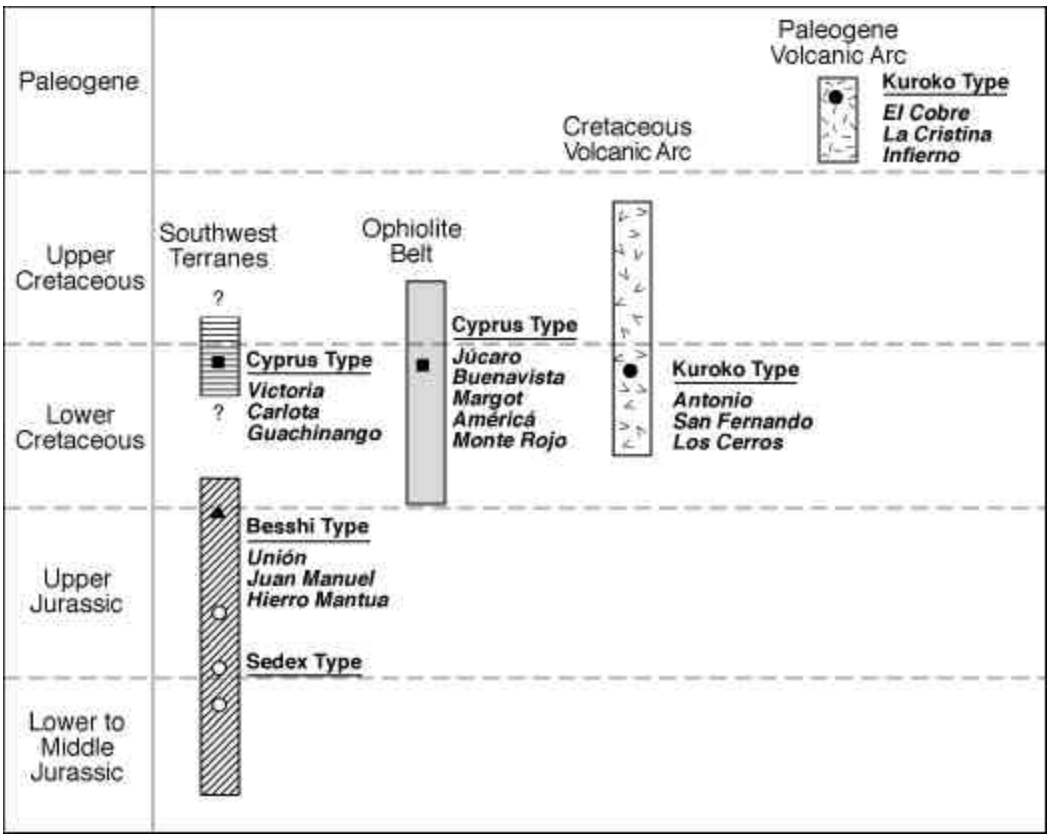

Figure 2. Age and distribution by terrane of Cuban VMS deposits.

Cyprus type deposits

VMS deposits of Cyprus type are best developed in the Cuban Ophiolite Belt. Júcaro and related deposits west of Havana have the form of massive lenses that are clearly stratigraphically controlled, but vein and disseminated mineralization is also present. The host rocks are the Encrucijada Formation, of Albian-Cenomanian age, consisting of porphyritic basalt, basaltic tuff, tuffaceous mudstone and limestone. The ore consists of pyrite, marcasite and chalcopyrite, with lesser sphalerite, pyrrhotite, enargite and bornite. Alteration minerals in the host rocks include quartz, epidote, sericite and chlorite.

East of Havana, Cyprus type deposits occur in the Margot Formation. The Margot deposit consists of massive and disseminated pyrite, with minor chalcopyrite and sphalerite. Mineralization occurs in basalt flows, in tectonic contact with serpentinite. The nearby América deposit is a pyrite lens in serpentinite breccia. The lens contains up to 75% pyrite with inclusions of pyrrhotite, and minor chalcopyrite.

The small Cyprus type deposits of Cuba Libre and Monte Rojo in eastern Cuba have not been exploited. The Cuba Libre deposit, near Camagüey, is associated with basalt, diabase and gabbro and has a reported reserve of 1.0M tonnes averaging 1% Cu. Monte Rojo deposit is a massive sulphide lens at the contact of serpentinite and gabbro.

In the Escambray Terrane (Figs.1 and 2), a group of unusual, possible Cyprus type, deposits are closely associated with ultramafic and mafic rocks that occur locally along a 70 km fault zone in a

metamorphic complex of marble and biotite schist. The deposits and their host ophiolitic rocks are interpreted to have been tectonically emplaced during the attempted subduction of the Escambray Terrane beneath the Cretaceous volcanic arc. There are three main deposits over a strike length of 10 km, but pyritic lenses are found over a distance of 40 km. The Guachinango deposit is a concordant lens of banded and massive pyrite with minor pyrrhotite, chalcopyrite, sphalerite and galena, containing 5M tonnes of 0.81% Cu. The composition of the Carlota deposit is similar, with 1.13% Cu and 0.28% combined Pb and Zn. The Victoria deposit has an estimated reserve of 0.54M tonnes, averaging 0.86% Cu and 0.39% combined Pb and Zn.

Kuroko type deposits

Kuroko type, or arc-related, massive sulphide deposits are known in the lower part of the Cretaceous arc in central Cuba and in the Paleogene arc in eastern Cuba (Fig. 2). The Los Pasos Formation, in the lower part of the Cretaceous arc in south-central Cuba, is considered to represent a bimodal volcanic assemblage of comparable age to the Primitive Island Arc assemblages on other islands of the Greater Antilles (Donnelly and Rogers, 1967). The formation consists of mafic volcanic rocks, often spilitized, and felsic volcanic rocks. Within the Los Pasos Formation are the massive sulphide deposits of Antonio, Los Mangos-San Fernando and Los Cerros. The deposits appear to be at a similar stratigraphic level and are associated with felsic pyroclastic rocks.

Kuroko type deposits are also known in the Paleogene arc of eastern Cuba. El Cobre was the first copper mine in the New World and began operation in 1544. Mining continued intermittently until 1998 and it is estimated that more than 3M tonnes have been mined at grades ranging from 2 to 20% Cu. Although almost all of the mined ore at El Cobre has come from a central cross-cutting vein system of pyrite and chalcopyrite, exploration in the area has demonstrated that there are a number of stratigraphically controlled sulphide lenses in El Cobre system, leading to the probability that the system includes both epithermal vein or stockwork mineralization and stratabound exhalative mineralization.

West of El Cobre probable Kuroko type deposits occur at La Cristina and Infierno. La Cristina deposit occurs in andesitic tuffs that are altered to quartz, sericite, chlorite and rare barite. The Infierno deposit occurs in andesite-basalt tuffs with intercalations of andesite-dacite. The mineralization is stratigraphically controlled and is underlain by a stockwork of disseminated sulphides and quartz. The host rocks are altered to quartz, chlorite, calcite and albite, with chlorite concentrated beneath the massive sulphides and sericite above and on the flanks.

Besshi type deposits

In the Guaniguanico block of western Cuba (Fig. 1), SEDEX deposits are common. The Matahambre mine produced copper for many years and the oxide cap of the Castellanos deposit is at present being mined for its gold. The known base metal deposits occur in three formations: in the south, copper deposits including Matahambre, occur in the San Cayetano Formation. Further north, in the Castellanos Formation, Zn and Pb-Zn deposits are present at Castellanos and Santa Lucia. In both formations mineralization is in carbonate-terrigenous sediments of the continental margin and their sedimentary-exhalative origin is widely accepted.

The most northerly belt of mineralization is in the middle part of Esperanza Formation of Upper Jurassic to Lower Cretaceous age, at the transition from terrigenous to carbonate-dominant sediments and includes the Hierro Mantua orebody and the Juan Manuel - Unión deposits. The host rocks to the mineralization are limestone and calcareous schist, with intercalations of sandstone, mudstone and carbonaceous schist. Volcanic rocks are represented as concordant lenses of basaltic to andesitic composition. The sulphide mineralization consists of pyrite and pyrite-chalcopyrite, with minor pyrrhotite, magnetite and enargite and forms discontinuous conformable lenses over a strike length of

30 km. Copper is the principal base metal present and Pb and Zn are insignificant. The Hierro Mantua deposit occurs mainly in sedimentary rocks, but the mineralization itself is concordant with a unit of porphyritic basalt. Although these deposits could also be included in the SEDEX category, they appear to be associated with volcanic horizons and may be classified as Besshi deposits (Kesler et al., 1996).

Conclusions

Cuba appears to have a higher content of VMS deposits than other islands of the Greater Antilles, particularly of the Besshi and Cyprus types. The Besshi type deposits, along with the even more abundant SEDEX deposits, in the Guaniguanico Terrane, are related to the continental rifting of Pangea near the present site of western Cuba and the preservation of Mesozoic continental fragments alongside the Cretaceous volcanic arc rocks; conditions that were not present in other Greater Antilles islands. Similarly, the collision of the Cuban portion of the Cretaceous volcanic arc with the Bahamas Platform, caused more intense tectonic compression there, compared to the eastern part of the arc, resulting in a higher percentage of outcropping ophiolitic rocks in Cuba compared to other islands of the Greater Antilles, and thus more abundant Cyprus type deposits.

Kuroko type deposits, are not particulary more abundant in the Cuban portion of the Greater Antilles volcanic arc. These deposits are present in the probable PIA rocks of Lower Cretaceous age in central Cuba and also in the Paleogene arc of Eastern Cuba, but are not known in the Upper Cretaceous arc. Perhaps the apparent lack of VMS deposits in the Upper Cretaceous arc rocks is simply a result of the paucity of outcrop, but it may be significant that the largest preserved area of Upper Cretaceous arc rocks, in east-central Cuba, contains widespread epithermal mineralization (Simon et al., 1999), suggesting that the presently exposed rocks were deposited in shallow water or subaerial conditions and not in an environment that favoured formation of VMS deposits.

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Biographical information

Norman Russell graduated from Queen's University, Belfast in 1966 with Honours in Geology and obtained a M. Sc. in Applied Geophysics from Imperial College, London in 1967. In 1973 he received a M. Sc. in Geology from the University of Toronto. He has practised as an exploration geologist in the Caribbean area for 25 years, including 15 years in the Dominican Republic. Since 1993 he has been engaged in exploration for gold and base metals in Cuba.