Comparison of Mineral Deposits between Georgian and Turkish Sectors of the Tethyan Metallogenic Belt

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ABSTRACT
Correlation between the Turkish and Georgian parts of the Tethyan Metallogenic Belt highlights the many similarities, particularly in the Cretaceous. VMS deposits are the most important deposit type and are largely of Kuroko-type in Turkey, although the stockwork type are predominant in Georgia, often with gold overprints. Eocene volcanics are host to vein precious metal deposits and become notably thick and alkaline immediately north of the Turkish Georgian border. Porphyry deposits appear to mainly associated with this event and contrast with the situation in Bulgaria. Other VMS deposits are associated with Jurassic volcanism and the eastern part of the area in Armenia has vein Au deposits and porphyries of Neogene age.

1 INTRODUCTION
Cursory examination of the metallogenic maps of Europe (Lafitte 1977) shows that the eastern Pontide metallotect (north of the North Anatolian Fault) is an extension of the Balkan belt and extends into the Transcaucasian republics, notably Georgia (Tvalchrelidze 1987). The recently published metallogenic map of Turkey (Engin et al. 2000) and the mineral occurrence map of the Transcaucasian republics show that the most important metallic deposits (with the exception of Mn) are associated with Cretaceous Eocene magmatism. However, comparison of deposits between the Georgian (Georgia) and Turkish (E Pontides) sectors of the Pontide belt has been difficult in the past because of political as well as language difficulties and published detailed comparisons are lacking.
2 COMPARATIVE GEOLOGY

There are obvious similarities between the geology of the Turkish Black Sea Coast and southern Georgia (Figure 1) and a number of authors (e.g. Okay and Şahintürk 1997, Yilmaz et al. 2000) have detailed this. The latter divided the region into broad zones (from N to S): Adjara- Triateli zone; Atrvin-Bolnisi zone; Bayburt-Karabakh zone.

The northern coastal (Adjara- Triateli) zone is dominated by a thick Cretaceous volcanic succession of island arc origin intercalated with limestones and clastic sediments. This is overlain by a thick (particularly in W Georgia) Eocene volcanics, particularly generated in a post-collisional rift environment.

In the Artvin-Bolnisi zone in the E Pontides, granites of Carboniferous age as well as a Jurassic sequence of limestones, black slate and volcanics are present under the Cretaceous and Eocene succession.

Correlation of the Turkish part of the Artvin-Bolnisi zone with Georgia is however hampered by the presence of Miocene-Quaternary volcanics that cap the entire border area. Although geophysical data indicate that the E Pontide section continues to the NE, the exact nature of the correlation is in doubt. Yilmaz et al. (2000) proposed a continuation along strike. In contrast, Akdeniz et al. (2000), suggested that a major fault offsets the eastern Pontides and correlated a section around Gümüşane with the Bolnisi area. In Georgia, the Bolnisi area has a basement of Carboniferous granite and sediment covered by Jurassic volcanics and a thick Cretaceous volcanic succession.

The Bayburt-Karabakh zone is an imbricate tectonised zone that contains largely Jurassic sediments and volcanics with ophiolitic slivers. The zone is covered for 100 km W of the Turkish-Armenian border but is clearly defined immediately to the E in Armenia.

3 MINERAL DEPOSIT CHARACTERISTICS

Comprehensive lists of the mineral deposits are available MTA (Turkey) and for Georgia by the Geological Institute and Caucasian Institute of Mineral Resources. The information for the eastern Pontides and Adjaran region of Georgia has recently been compiled into a data base by Buadze et al.1997 and digitized by the present authors. Comprehensive data for the Bolnisi district have been compiled by the authors from archives of geological institutes in Tbilisi.
3.1 VMS Deposits

These are currently the major focus of mining and exploration operations in both countries. In Turkey, the deposits occur in a number of clusters (from West to East, Fig.1): Lahanos, Kutlular, Çayeli, Murgul, Artvin as well as other minor occurrences. The styles vary considerably, with Lahanos and Çayeli areas dominated by polymetallic black and yellow ores, of Kuroko type (Catagay 1993, Hobbs 2000). In contrast, the Murgul ores currently mined are predominantly of the stockwork type and have been suggested as transitional to porphyry coppers deposits by Özgür (1993).

A further difference between deposits is their gold content. Although gold is enriched in many deposits, notably in black ores, some deposits are particularly enriched. For example, the Cerattepe deposit near Artvin contains -5 g/t Au in oxidised barite rich units associated with intense silicification (Ciftehan and O'Brien, 1998), suggesting an epithermal overprint.

The major mineralised district in Georgia is the Bolnisi area. This contains 5 major polymetallic prospects, with a further 64 occurrences. The best exposed of these is the Madneuli mine, which has been mined since 1965. Detailed re-mapping of the pit by R.M. has shown that mineralisation is associated with a rhyolitic dome, probably with limited discharge of fluids to the sea floor. The overall form of the mineralisation is similar to the Murgul open pits, with predominant stockwork pyrite and chalcopyrite, although minor black ore zones and veins, as well as barite, are present at the top of the deposit. Madneuli is currently (2000) mined for oxide Au ore. The Au rich zone occurs as an oxidised pod and as a siliceous zone on the N side of the sulphides, reminiscent of Cerattepe. The main phase of mineralisation appears to be prior to caldera collapse and ignimbrite generation (K/Ar: 93-85 Ma). This style of mineralisation is repeated at other major prospects in the district.

A less important, but related, mineralisation style in the Bolnisi district is disseminated Au in silicified and argillised tuffs at Sakdrisi (Gugushvili and Hart, 2000). The age of mineralisation is constrained to 77.6-83.5 Ma by K/Ar dating on host rocks and overlying unaltered ignimbrite.

To the south of Bolnisi, volcanogenic mineralisation is hosted in mid-late Jurassic volcanics at Alaverdi and Kafan in Armenia.
3.2 Porphyry Deposits

Although not economic at present, a number of porphyry deposits of both Cu-Mo and Cu-Au type have been discovered in the E Pontides Çamur et al.(1995) represent the deposits as forming a linear belt to the south of the VMS belt. However, the true position appears more complex with porphyry prospects also occurring in the NE of the E Pontides. The major Cu-Mo deposits at Güzelyayla and Ulutaş have been investigated in detail and the host pluton at Ulutaş has been dated at 132±5 Ma by Giles in Taylor and Fryer (1980), although determinations on the prospect as well as the Bakircay prospect give ~38 Ma. Moore et al. (1980) suggested a modal age at ~80 Ma for Pontide granitic magmatism with later phases at 45 and 25 Ma. Skarn magnetite deposits, sometimes with Cu, are known at the contact of Jurassic-lower Cretaceous units with granitoids (Aslaner et al. 1994).

Exploration in the Artvin area has defined a Au rich porphyry dated as Eocene (K/Ar: 51-54 Ma, Röckl, 1998). Similar prospects are known immediately to the N across the Georgian border at Merisi associated with intrusives of probable middle-Eocene age (Magalashvili 1991) and to the NE near Borjomi at Garta (Buadze et al 1997).

3.3 Veins

A variety of vein deposits are known in the Turkish part of the belt, although few are currently of interest.

The major economic deposits are epithermal Au± base metal deposits. A major prospect at Mastra is at the development stage and is hosted in Eocene volcanics (Tüysüz et al 1995). The stratigraphicallocation of other prospects is uncertain, for example, Bahcecik (Yigit et al. 2000). This could either be of Upper Cretaceous or Eocene age, although Yigit et al. favour the latter. Other significant Au veins occur Altintepe, near Fatsa, and at Akoluk, Ordu in Cretaceous volcanics (Tüysüz and Akçay 2000).

Related precious metal deposits include the Eocene limestone hosted prospect at Kaletaş near Gümüşane (Çubukçu and Tüysüz 2000).

Vein mineralisation is not well developed in Georgia, although the original discovery of the Bolnisi district was due to the recognition of gold placers, probably derived from minor veins.
3.4 Other Deposits
Minor manganese deposits are widespread in the mid-Cretaceous volcanics overlying the favourable host for VMS deposits.

4 DISCUSSION AND CONCLUSIONS
The plate tectonic setting of mineralisation in the E Pontides and Georgia remains very much a matter of debate. Although all authors are agreed on the island arc affinity of the area, opinions on the polarity of subduction with time differ sharply. The simplest reconstructions are those of Banks and Robinson (1997) who argue for N dipping subduction throughout the history of the area. Others (e.g. Röckl, 1998) have argued for the flipping of subduction on collision between the Pontide Arc and Anatolia and southward subduction during the Eocene.

What are certain are the distinct differences between the Pontides and the Sredno-Gorie zone of Bulgaria and Serbia, as discussed by jankovic (1980). The Sredno-Gorie zone is dominated by porphyries and related replacement massive sulphides (often containing enargite) e.g. Medet, Asarel, Elshitsha, Chelopech and Bor. This is in contrast to the VMS deposits of the Pontides and Bolnisi district in which porphyry and vein Au deposits appear to be temporally later than VMS deposits, perhaps reflecting the greater relief and preservation potential in the early Tertiary. Based on this comparison the Eocene volcanics in Adjara appear to have Au potential both for veins and for Cu-Au porphyries.

The Bolnisi sector of the belt appears to be surprisingly lacking in Tertiary vein deposits. However the ultramafics on the southern side of the belt along strike in SE Armenia host the major Zod and smaller Megradzor Au deposits of Neogene age. Major porphyry Cu-Mo deposits also occur to the south of the probable suture zone and have been dated at -22 Ma.

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References


Lafitte, P. 1977. Metallogenic Map of Europe. UNESCO.


Figure 1. Geology and Mineral Deposits
Sources: Guven (1993) and sources in text.