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# Occurrence of gold mineralization in rocks of Proterozoic Delhi Supergroup around Ambaji, Banaskantha District, Gujarat

We report here the occurrence of gold in a polymetallic (copper–lead–zinc) sulphide deposit of the Ambaji mining area in Gujarat, India. The Ambaji mine (24°34′53″ : 72°84′49″) is located at village Ambaji, Taluka Danta, Banaskantha District, Gujarat (Figure 1) at the southern termination of the Ambaji–Deri–Banaskantha polymetallic sulphide mineralized southern Delhi fold belt. The rock formations of Ambaji area belong to the Proterozoic Basantgarh Formation of Kumbhalgarh Group of Delhi Supergroup and form a part of the main Delhi synclinorium of Heron[1]. They consist of metasediments and metavolcanics. Metasediments are represented by calc–silicate rocks, dolomite, marble, biotite–schist, quartz–sericite-schist, talc–tremolite–chlorite schist and biotite–hornblende gneiss. Metavolcanics comprise of epidiorite and amphibolite. Metarhyolits have also been found in the Deri–Ambaji mine area[2]. These rocks have undergone upper greenschist to lower amphibolite facies regional metamorphism and are intruded by 990 Ma Ambaji granites[3].

About 5.5 million tonnes (mt) of measured and indicated reserves of polymetallic sulphide deposits have been reported from Ambaji area. Chief ore minerals are galena, sphalerite, chalcopyrite and pyrite. The sulphide mineralization is mainly hosted by hydrothermally altered felsic metavolcanic rocks now represented by quartz–biotite–sericite schist, phylite–chlorite schist, talc–tremolite schist, biotite–amphibolite-gneiss/schist and amphibolites[4].

Surface indications of mineralization in the area are mainly limonitization and development of malachite and azurite. Both massive and stratiform types of mineralization are observed. The promising mineralization zone is highly sheared and folded. The general trend of amphibolite and hornblende–biotite schist is N64°W–S64°E and dip 30° northeasterly. The general trend of shear zone is E–W. Many workers have suggested that the mineralization in the area is of volcanogenic massive sulphide type[5].

It is well known that silver is associated with the lead–zinc ores of Ambaji–Deri–Banaskantha belt. There are no reports of platinum group elements (PGE) and gold in the Ambaji deposit. Gold, platinum and palladium associated with sulphide minerals are reported here.

Nine grab samples were collected from the bedrock of amphibolite, limonitized sulphide ores, quartz–biotite–sericitie schist and biotite–hornblende gneiss/ schist exposed in the Ambaji mines area. The samples were analysed for PGE and gold by fire assay combined with ICP–AES technique at the Central Chemical

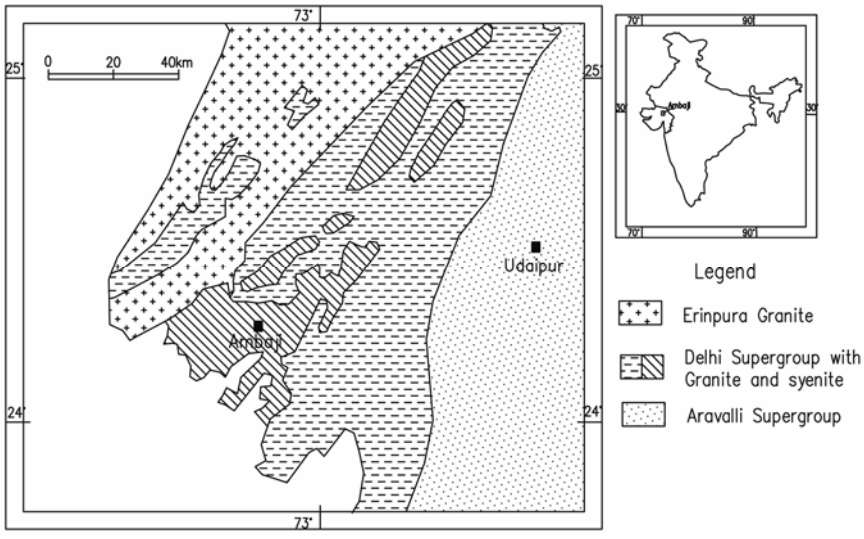


**Figure 1.** Map showing the location of Ambaji mine in Gujarat. (Modified after GSI, 1980.)

**Table 1.** Platinum group elements and gold values analysed by fire assay cum ICP–AES method

| Sample no. | Platinum (ppb) | Palladium (ppb) | Gold | Sample description | Latitude : Longitude |
|---|---|---|---|---|---|
| AMB–1 | < 5 | < 5 | < 50 ppb | Muscovite–biotite schist | 24°34′55″ : 72°84′59″ |
| AMB–2 | < 5 | 35 | < 50 ppb | Quartz–sericite schist | |
| AMB–3 | < 5 | < 5 | 1 ppm | Sulphide ores | 24°34′53″ : 72°84′49″ |
| AMB–4 | < 5 | < 5 | 750 ppb | Quartz–sericite schist | 24°34′55″ : 72°84′52″ |
| AMB–5 | < 5 | < 5 | 50 ppb | Phyllite | |
| AMB–6 | < 5 | < 5 | 60 ppb | Quartz–sericite schist | |
| AMB–7 | < 5 | < 5 | 1.95 ppm | Amphibolite | 24°34′50″ : 72°84′49″ |
| AMB–8 | < 5 | < 5 | 50 ppb | Phylite–chlorite schist | 24°34′53″ : 72°84′69″ |
| AMB–9 | < 5 | < 5 | < 50 ppb | Talc–tremolite schist | |

Laboratory, Geological Survey of India, Kolkata. The analytical results are presented in Table 1.

These results reveal that out of nine samples, three show values of 1.95 ppm, 1 ppm and 750 ppb for gold, while the platinum and palladium values are below detection limit. The dissemination of galena has also been reported in amphibolite of the Ambaji mine sequence (Golani, P. R., 2010 unpublished). In view of the occurrence of gold mineralization with VMS type Cu–Zn sulphide at Danva in Sirohi District, Rajasthan[6], the present report of gold mineralization calls for detailed sampling, and ore petrographic and geochemical studies for understanding the mode of occurrence and environment of deposition of gold in sulphide ores.

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# Tricotyledony in critically endangered plant, *Ceropegia mahabalei* Hemadri et Ansari (Apocynaceae)

The presence of two cotyledons is the characteristic feature of dicotyledons, but sometimes additionally one cotyledon can be produced. The origin of tricotyledonous seedling may be due to genetic variability and is referred to as tricotyledony or tricotyly. Occurrence of tricotyledony was reported in a few tree species, viz. *Acacia mellifera* (Vahl) Benth.[1], *Butea monosperma* (Lam.) Taub.[2] and *Emblica officinalis* Gaertn.[3]. This phenomenon was also reported in shrubs like *Hippophae rhamnoides* L.[4] and *Withania somnifera* (L.) Dunal[5]. Here we deal with tricotyledony observed during the seed germination experiment for *in vitro* micropropagation of the critically endangered tuberous plant *Ceropegia mahabalei* Hemadri et Ansari.

*C. mahabalei* Hemadri et Ansari (Apocynaceae), locally known as 'Gauti Kharpudi', is endemic to the Western Ghats of Maharashtra[6]. Tubers of this plant are rich in carbohydrates and are consumed by the local people. This species is so far known only from its type locality, i.e. Ralegaon Hills about 10 km west of Junnar, Pune District, Maharashtra[6]. The species grows on exposed slopes of the hills among grasses at an altitude between 1000 and 1100 m. It has been included in the *Red Data Book*[7], been treated as Critically Endangered[6] and has been included in the IUCN Red list[8]. IUCN has also recommended large-scale *in vitro* propagation for conservation of this plant species[8].

Follicles of this species were collected in December 2010 from natural population at Ralegaon Hills. For germination studies, the follicles were cut longitudinally along their sutures to obtain the seeds. Seeds were first washed with running tap water for 10 min and then soaked in Tween-20 solution (2–4% v/v) for 2–5 min. Thereafter, the seeds were washed twice with distilled water and surface-sterilized with 0.1% (w/v) freshly prepared aqueous mercuric chloride for 5 min. Finally, these seeds were washed thrice with sterile distilled water