Occurrence of gem variety green sphalerite and dyscrasite in rocks of the Aravalli Supergroup, India

The Zawar Belt in Udaipur district, Rajasthan (Figure 1), the host of polymetallic assemblage of Pb, Zn, Ag, Cd has a history of mining and smelting for zinc going back to 2100 years old[1–3]. Recently, green coloured gem variety of sphalerite has been found in Zawar mine associated with galena and dyscrasite (Ag_3Sb). This variety is different from the conventionally mined ore mineral of Zn which is mainly brown and honey brown in colour. This is the first report of green sphalerite from India. Previously it has been reported from Madan Orefield, Bulgaria[4]. The major rock types in Zawar Belt are arkosic quartzite, greywacke, phyllite, carbonaceous phyllite and dolomite of the Aravalli Supergroup of the Palaeoproterozoic age. The Pb–Zn mineralization is mainly confined to the dolomite of Baroi Magra Formation, Udaipur Group, Aravalli Supergroup.

Lead–zinc mineralization in Zawar Belt is mostly confined to dolomite, although minor disseminations of pyrite have been reported at a few places in the enclosing phyllite[5]. Mineralization occurs in the form of galena and sphalerite. The other common sulphide minerals are pyrrhotite and pyrite with accessory arsenopyrite. Silver and cadmium are mainly associated with galena and sphalerite respectively. Mineralization mainly occurs as massive aggregates and as fracture fillings. However, laminated ore is also present within inter banded phyllite and dolomite. Mineralization occurs in Zawarmala mine as thick, folded and broken lenses of varying ore concentrations.

Green sphalerite sample collected from Zawarmala underground mine of Hindustan Zinc Limited (HZL) from –30 mRL is found to be associated with galena and occurs in the form of patches. It is characterized by translucent light green colour, resinous lustre with well-developed crystals and perfect dodecahedral cleavage (Figure 2 *a*). In the light of the well-known fact that gem sphalerite has a dispersion which is three times higher than that of diamond, the present finding becomes very significant.

Petrographic studies show that gem variety sphalerite occurs as fine aggregates in association with galena and dyscrasite (Ag_3Sb). It shows light green colour, is non-pleochroic and isotropic (Figure 2 *b*). Under reflected light, it shows low reflectance and internal reflection (Figure 2 *c*). Blue to bluish grey Dyscrasite (Ag_3Sb) has metallic lustre and extremely high reflectance. It is weekly pleochroic and feebly anisotropic in nature and occurs as small aggregates within galena preferably at the grain margins (Figure 2 *d*). Although occurrence of dyscrasite is reported from Agucha mine[6], it was not reported earlier from Zawar mine. Mineral analyses of samples were carried out using CAMECA SX 100 electron microprobe analyser (EPMA) in the Geological Survey of India's National Centres of Excellence in Geoscience Researches (NCEGR) laboratories at Faridabad. Operating conditions were 20 kV accelerating voltage and a probe current of 15 nA. Analyses were done using a beam diameter of 1 μm, 5 sec counting time along with natural standards.

EPMA study has revealed the presence of sphalerite, galena and dyscrasite (Figure 3 *a–d*). It shows that Zn content of gem variety sphalerite is higher (65.41–65.91 wt%) than that of common brown sphalerite (57.15–60.39 wt%)[7].

Similarly the Ag content in dyscrasite from Zawar area is higher (82.27–83.91 wt%) than that of Agucha area (69.06–77.24 wt%)[6]. The mineral analyses of ore minerals (15 point analysis) are presented in Table 1.

Discovery of this rare, green gem variety sphalerite from Zawar Belt adds a new dimension to the Pb–Zn mineral

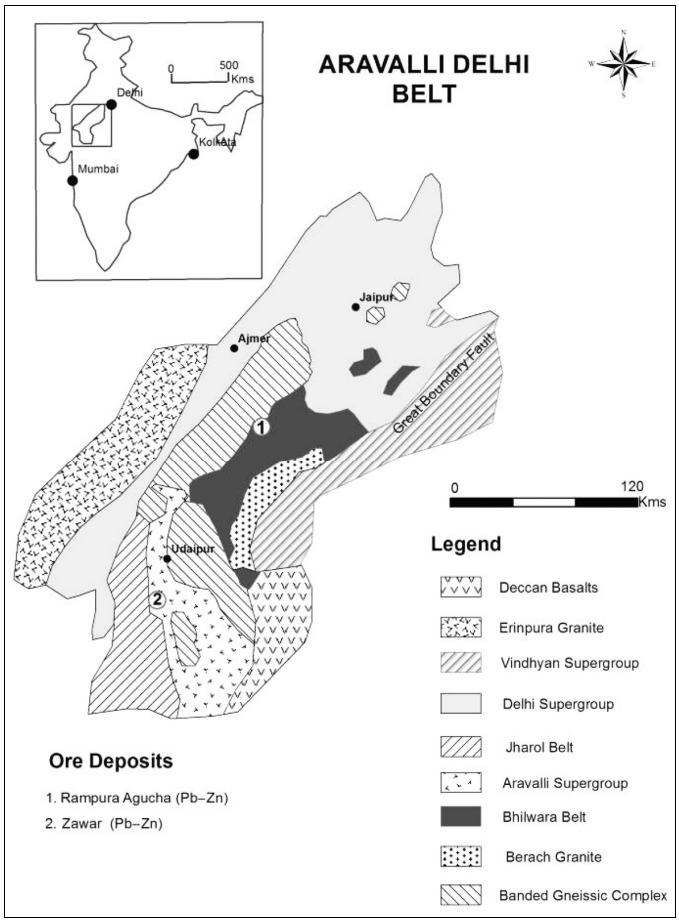

Figure 1. Geological map of the Precambrian Aravalli Delhi Belt (ADB) (modified after Sugden *et al.*[1]) showing the locations of the Zawar and Agucha Pb–Zn sulphide deposits. The inset is a map of India showing the geographic location of ADB.

Table 1. EPMA analysis of sulphide phases, Zawar, Udaipur district, Rajasthan

Data set/point	1/1	2/1	3/1	4/1	5/1	6/1	7/1	8/1	9/1	10/1	11/1	12/1	13/1	14/1	15/1
Weight%	Sphalerite					Galena					Dyscrasite				
Fe	0.13	0.11	0.08	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cu	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Zn	65.91	65.79	65.63	65.62	65.41	0.00	0.00	0.00	0.66	0.04	0.71	0.20	0.03	0.00	0.02
Ni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cr	0.00	0.02	0.00	0.00	0.04	0.00	0.06	0.00	0.01	0.00	0.00	0.02	0.00	0.02	0.03
Mn	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Co	0.04	0.01	0.02	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00
As	0.02	0.00	0.01	0.02	0.04	0.00	0.00	0.00	0.00	0.04	0.23	0.24	0.39	0.24	0.38
S	32.77	32.44	32.23	32.23	32.3	13.30	13.30	13.51	13.62	13.83	0.79	0.25	0.06	0.09	0.05
Mo	0.26	0.60	0.50	0.46	0.58	0.21	0.14	0.16	0.33	0.14	0.13	0.00	0.00	0.00	0.00
Ag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	83.17	82.82	83.91	83.08	82.27
Cd	0.29	0.36	0.26	0.43	0.45	0.01	0.00	0.00	0.00	0.00	0.78	0.95	0.56	0.70	0.62
In	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sn	0.00	0.08	0.05	0.00	0.00	0.10	0.00	0.01	0.00	0.08	0.00	0.00	0.00	0.00	0.00
Sb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.75	16.77	16.83	17.00	17.15
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Te	0.11	0.00	0.00	0.05	0.00	0.00	0.00	0.021	0.01	0.05	0.00	0.00	0.00	0.00	0.00
W	0.00	0.07	0.00	0.12	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Au	0.00	0.00	0.00	0.05	0.00	0.00	0.02	0.05	0.09	0.13	0.00	0.00	0.00	0.00	0.00
Pb	0.00	0.00	0.00	0.00	0.00	85.81	86.54	86.22	86.01	86.52	0.00	0.06	0.00	0.02	0.03
Bi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02
Cl	0.01	0.00	0.00	0.00	0.00	0.02	0.02	0.05	0.04	0.05	0.07	0.06	0.04	0.05	0.07
Total	99.55	99.53	98.81	99.04	98.96	99.48	100.19	100.07	100.82	100.93	101.67	101.43	101.87	101.31	100.68

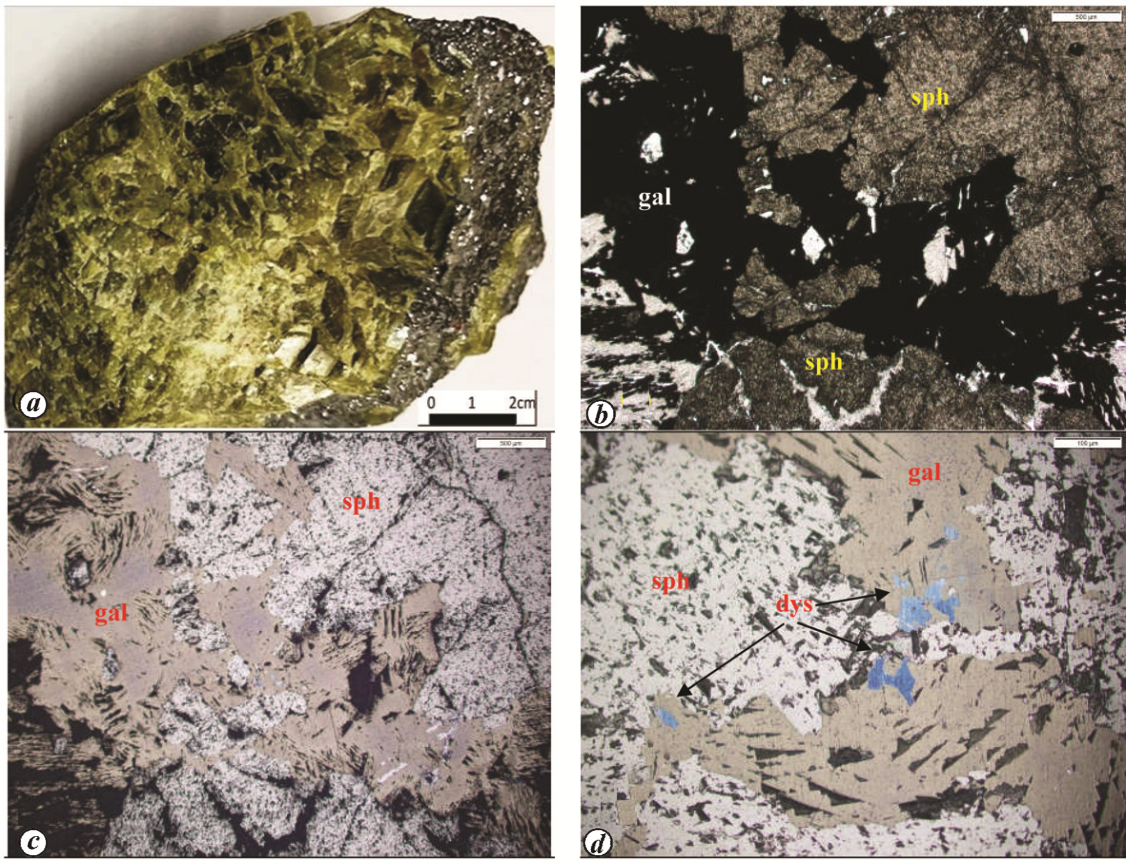

Figure 2 *a–d*. Images of green sphalerite and galena. ***a***, Hand specimen of green sphalerite and galena from Zawarmala mine. ***b***, Association of green sphalerite and galena (plane polarized light). ***c***, Green sphalerite and galena under reflected light. ***d***, Photomicrograph showing occurrence of sphalerite, galena and dyscrasite.

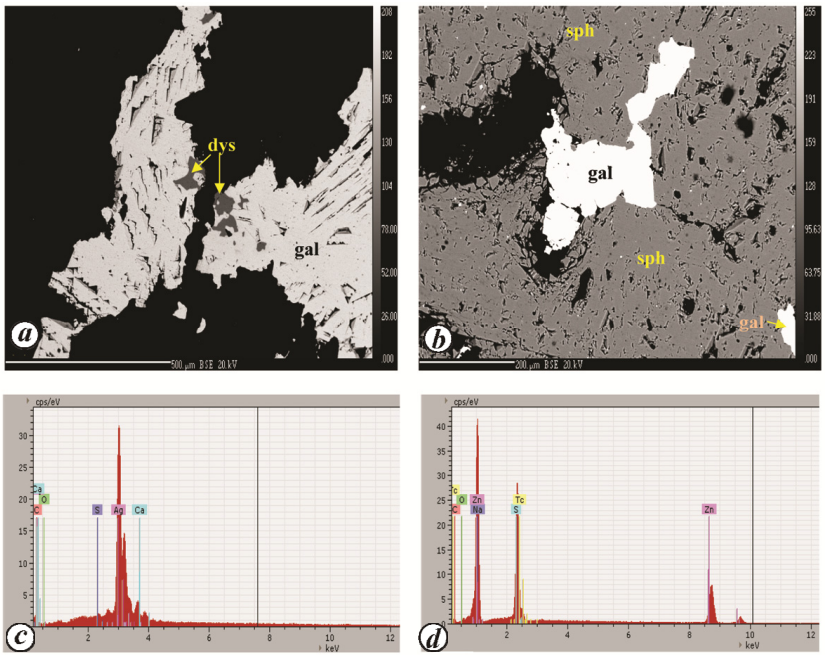

Figure 3 ***a–d.*** EPMA studies of galena and sphalerite. ***a***, BSE image of galena and dyscrasite in Dolomite, Zawar Mine.; ***b***, BSE image showing occurrence of green sphalerite and galena; ***c***, Spectrum of Ag (dyscrasite). ***d***, Spectrum of Zn (sphalerite).

belts of India and Zawar Belt in particular. The green colour of sphalerite is due to the presence of trace amounts of Co and Fe in it. The typical properties of sphalerite, viz. translucent light green colour and very high dispersion make it a worthy gem stone. Therefore, further search for this variety of sphalerite may be given priority in the Zawar Belt. This study appears to be the first report revealing the presence of dyscrasite in Zawar Belt of Udaipur district.

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Invasion of living fossil bivalve, *Dosinia japonica* (Reeve, 1850) along the Indian coast

Phylum Mollusca is the second largest group of invertebrates and comprises soft-bodied animals. They occur in diverse habitats such as freshwater, estuarine, marine, terrestrial and arboreal. Benthic organisms are living on or in the substratum of water bodies. Many organisms are permanently attached to the bottom. Among molluscan species, bivalves are larger and thus more visible. They exhibit a variety of body shapes, reproductive modes and feeding styles[1]. Bivalves are filter-feeding organisms and can purify silted marine waters[2]; they form an important link between the consumers and primary detritus and thus play significant role in nutrient recycling.

Invasive species have been a growing problem around the world since several decades[3]. They have an impact on the new environment, such as importing new diseases and competing with native organisms for space and food[4]. Venerid clams are suspension filter-feeders. They live buried in shallow marine waters and are common along the mainland coasts, but less abundant in the islands. According to Rao[5], Veneridae is a large family consisting of 172 genera and approximately 800 of venerid clams thus far. Among these, 82 species are placed under 25 living genera in India. Under genus *Dosinia* around 15 subgenera are recognized, but the distinguishing characters are not yet clear[5]. Rao[5] also described seven *Dosinia* spp., namely *Dosinia bruguieri*, *D. cretacea*, *D. fibula*, *D. histrio*, *D. prostrate*, *D. tranquebarica* and *D. tumida* which are found in India. Distribution of *D. japonica* is also confined to coastal waters of Malaysia and Indonesia, Korean peninsula, Japan and Russia[6]. In Japan, this species was reported in an extensive geographic