FIRST OCCURRENCE OF GEM SPHENE IN SRI LANKA

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INTRODUCTION

Once more, the careful investigation of a mixed parcel of tourmalines from Sri Lanka has yielded a surprising result. This study deals with an oval, faceted, brown stone, which attracted attention because of its shining inclusions located slightly below the table facet. This feature is unknown in tourmalines. The result of a refractivity measurement was negative; that is, the refractive index must be higher than 1.8. On the basis of its specific gravity and the observed absorption spectrum showing didymium-lines, the stone was suspected to be a sphene. Because sphene of gem quality has not to date been reported from Sri Lanka, it was necessary to undertake a mineralogical and chemical investigation of this stone. At the same time, three additional sphenes from well known localities were analysed as a means of comparison. They are described in Table 1.

TABLE 1
Sample description

No. 1 Yellow-green faceted gem from Madagascar, 0.49 ct: SG = 3.52
No. 2 Green crystal fragment, Swiss Alps (too small for RI measurement)
No. 3 Emerald-green crystal from Baja California, Mexico, 4.99 ct: SG = 3.53
No. 4 Dark brown faceted gem with oval form, from Sri Lanka, 4.48 ct: SG = 3.52

CHEMISTRY

Although the chemical formula of sphene is simply $CaTiSiO_5$, this mineral normally contains small proportions of foreign elements. There is a substitution of major elements by minor proportions of rare-earth elements and others. It was observed that

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TABLE 2

Microprobe analyses of gem-material sphenes

	1	2	3	4
SiO_2	29.87	29.72	29.92	29.92
TiO_2	37.63	38.39	38.39	38.61
Al_2O_3	1.21	1.06	.82	.85
Fe_2O_3	.60	.69	.26	.45
Cr_2O_3	.21	.16	.38	.00
MnO	.23	.00	.00	.00
MgO	.09	.00	.06	.17
CaO	28.63	28.78	28.97	28.53
Na_2O	.02	.00	.00	.40
K_2O	.03	.02	.03	.03
Total	98.52	98.82	98.83	98.96
Si	0.9934	0.9844	0.9912	0.9897
Al	0.0474	0.0414	0.0320	0.0331
Ti	0.9411	0.9569	0.9564	0.9604
Mg	0.0044	0.0000	0.0029	0.0083
Fe	0.0150	0.0174	0.0064	0.0112
Cr	0.0031	0.0041	0.0099	0.0000
Mn	0.0064	0.0000	0.0000	0.0000
Na	0.0012	0.0000	0.0000	0.0256
Ca	1.0202	1.0221	1.0283	1.0111
K	0.0012	0.0008	0.0012	0.0012

Analyst H. Schwander, Basel.

oxides in weight-%; number of ions on the basis of 5(O)

1 yellow-green sphene from Madagascar

2 yellow-green sphene from the Swiss Alps

3 emerald-green sphene from Mexico

4 dark-brown sphene from Sri Lanka

The sample from Sri Lanka contains approximately 0.5% Nb. Further rare-earth elements were not detected by this analytical determination.

Ca could be replaced in small quantities by Na,Mn,Sr,Ba. Furthermore, Ti could be substituted in slight amounts by Al,Fe,Mg,Nb,Ta,V,Cr. Finally oxygen indicated a small degree of replacement by OH or F. In sphenes, traces of rare-earth elements are characteristically found. Among these, Ce and Y are common, and Nd and Pr cause an absorption spectrum in which a group of fine lines appears in the yellow region. In order to have a means of comparison of the chemical analysis of the stone from Sri Lanka, the additional three sphenes from Table 1 were analysed as well. The analyses were made using an ARL electron microprobe, operating the wavelength dispersive method as well as the energy dispersive method. The chemical standards were silicates with simple compositions (minerals) and oxides. All samples were coated with carbon in order to have a conductive surface. The analytical results are presented in Table 2. The main constituents of all samples are fairly constant; minor elements differ in small limits. The concentrations of the trace elements are too low to be analysed by the microprobe. Nevertheless the sample from Sri Lanka showed a small Nb peak, and a concentration of 0.5% was estimated. The dark brown colour is not necessarily related to the total iron content as indicated by samples No. 1 and 2, which are both lighter in colour than No. 4, yet have a higher iron concentration. Literature indicates that the brown colour is due to iron, with as little as 1% Fe_2O_3 causing a dark brown stone.

Optical Properties of the Stone from Sri Lanka

The most attractive sphenes have a bright yellow, green or brown (blue and red are also reported) colour which does not completely obscure the strong dispersion, thus such stones produce a remarkable fire. The stone No. 4 is lacking in such fire, its dark brown colour masking this esteemed property. Because of the high refractive index of sphene we had to use a special Riplus type refractometer. The values, including the comparative stones, are shown in Table 3. Stone No. 2 was too small to get a reading.

The obvious inclusions in the stone consist of disc-shaped fine tension fissures similar to those seen in metamict zircons from Sri Lanka. These fissures are oriented parallel to each other, and no mineral grains were discovered which could have caused the defects, using both microscope and microprobe.

TABLE 3
Refractive Indices

	$n\alpha$	$n\gamma$	DR
No. 1	1.910	2.070	0.160
No. 3	1.908	2.080	0.181
No. 4	1.909	2.099	0.190

The absorption spectrum is as reported in many books, the typical rare-earth spectrum. It consists of a group of fine lines in the yellow. Further lines are not seen in the hand spectroscope. Table 4 shows the absorption spectrum recorded with an ultraviolet spectrometer Pye Unicam SP 8-100 under rapid scanning conditions, but narrow band width (0.5 nm). Wavelength indications are accurate to ±0.5 nm or better. General absorption for the very dark red-brown ray starts below approximately 470 nm, the lighter greenish-brown ray below about 440 nm. The peak positions are not sensitive to crystal orientation; the absorption intensities, however, depend strongly on it.

The spectrum essentially is identical with those of yellow and green sphenes, except for the much lighter line intensities in the described brown Sri Lanka stone. The attractive green sphenes from Baja California have additional bands and lines due to chromium.

Occurrence

Sphene occurs as a common accessory mineral in magmatic as well as in metamorphic rocks. In Sri Lanka it is reported from wollastonite-bearing gneisses of the Galle Series and from gneisses close to the hill country, in which it appears much rarer (H. S. Gunaratne, personal communication). Although these rock-forming sphenes do not reach cuttable sizes, it is surprising that the subject of this paper originates from a remote area near Galle.

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TABLE 4

Absorption spectrum of sphene from Sri Lanka

The absorption spectrum consists of four line-groups

	Int.	nm		Int.	nm
Group 1	m	820	Group 3	vw	596
	vw	813		vw	593
	st	806		w	590
	m	799		vw	587
	m	795		m	586
	vw	789		w	582
				w	579
Group 2	vw	779		vw	575
	vw	776		vw	573
	vw	771		w	569
	w	764			
	st	751	Group 4	vw	536
	vw	746		vw	533
	vw	744		w	528
	vw	741		vw	524
	w	739		w	512
	m	732			

Intensities: st = strong, m = medium, w = weak, vw = very weak

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