

## REDDISH-BROWN SAPPHIRES FROM UMBA VALLEY, TANZANIA

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### INTRODUCTION

As known to the gemmologist and jeweller, East Africa's famous gem locality, Tanzania, is well known not only for garnets of various colour varieties, but also for corundums of many colours and hues. The occurrence of corundum in Tanzania is reported by many researchers (Zwaan, 1974; Dolenc, 1976; Amstutz & Bank, 1977; Bank, 1978). However, these reports mainly describe the common corundum varieties such as ruby and blue and yellow sapphires. Recent observations made by the author on new occurrences of sapphires from Umba Valley revealed a reddish-brown colour variety which has often been termed as 'padparadschah' in the trade. It therefore became necessary to investigate systematically the differences between the 'real' padparadschah and this new occurrence. The chemical and physical properties of the latter are given with special emphasis on the cause of colour. Further, the inclusions are reported, which may be of help in documenting the locality.

### CHEMICAL AND PHYSICAL PROPERTIES

Visual colour observations revealed a reddish-brown to brownish-orange body colour often with a yellowish or greenish tint. According to the DIN colour system the colour indices were between 6:6:2 and 7:5:2. Stones with a darker body-colour showed distinct dichroism, which may be helpful to the field gemmologist in separating them from similarly coloured *pyralspite* (or *umbalite*) garnets, which also occur commonly in this locality.

The chemical composition of four samples was analysed by an ARL electron microprobe. Transition metal ions were detected to determine the cause of colour (described below). The analytical values along with the determined refractive indices and specific gravity are given in Table 1.

TABLE 1. The physical and chemical data of reddish-brown sapphires from Umba Valley, Tanzania.

Sample:	1.	2.	3.	4.
Carat weight:	7.80	3.25	1.97	0.88
Colour:	reddish-brown	reddish-brown with a greenish tint	reddish-brown	reddish-brown
Dichroism:				
o — ray:	brownish-orange	brownish-orange	purplish-red	weak for visual
e — ray:	yellowish-green	yellowish-green	greenish	observations
Refractive indices:				
$n_{\omega}$ :	1.771	1.771	1.773	1.773
$n_{\xi}$ :	1.763	1.763	1.765	1.765
Birefringence:	-0.008	-0.008	-0.008	-0.008
Specific gravity at 4 °C*:	4.02	3.99	4.05	4.06
Microprobe analysis (oxides in Wt %)				
Fe <sub>2</sub> O <sub>3</sub> †	1.10	1.10	1.53	1.62
Cr <sub>2</sub> O <sub>3</sub>	0.12	0.13	0.09	n.f.
TiO <sub>2</sub>	n.f.	0.36	0.03	0.03
V <sub>2</sub> O <sub>5</sub>	n.f.	n.f.	n.f.	n.f.

\* accuracy  $\pm 0.01$ 

n.f. = not found (below detection limit of the microprobe)

† the total iron is calculated as Fe<sub>2</sub>O<sub>3</sub>

## CAUSE OF COLOUR

The basic possibilities existing for colour of corundum are due to transition metals such as iron, titanium, chromium and vanadium or to lattice imperfections. Experiments have shown that in natural corundum the colour is mainly due to the usual presence of two or more transition metal ions as opposed to the rare occurrence of a single chromophore. If a colour is produced by a single transition metal ion the result is a basic colour which may be green to yellowish-green (due to  $\text{Fe}^{3+}$ ) or pink (due to  $\text{Ti}^{3+}$ ) or red (due to  $\text{Cr}^{3+}$ ) or reddish-green to greyish (due to  $\text{V}^{3+}$ ). Lattice defects may cause a yellowish colour in corundum (Schmetzer & Bank, 1981a and b; Schmetzer *et al*, 1982).

According to the data in Table 1, the reddish-brown stones from Tanzania contained a higher percentage of iron than of the total Cr and Ti content. However, the microprobe cannot determine the oxidation state of iron. It is probable that  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  are in different sites within the crystal lattice, causing a somewhat darker hue to the body-colour of the stone. On the other hand the possibility exists that lattice defects also influence the colour of these sapphires, with different positionings of  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Cr}^{3+}$  and  $\text{Ti}^{4+}$  within the lattice. Both these explanations can apply to the coloration of the reddish-brown colour in sapphires from Tanzania. The minute quantity of  $\text{Cr}_2\text{O}_3$  is easily masked by the much larger proportion of iron oxides present. Therefore these stones cannot be referred to as *padparadschah*, whose colour is due to  $\text{Cr}^{3+}$  and  $\text{Ti}^{4+}$ .

## ABSORPTION AND ULTRAVIOLET BEHAVIOUR

Schmetzer & Bank (1981a) mentioned that the absorption spectrum of corundum can be due to the presence of one or more metal ions within the structure, which may also lead to the superposition of several basic types of spectra. This type of absorption spectrum was noted with those reddish-brown stones from Umba Valley.

The two colour-causing metals found are iron and chromium, in variable proportions producing orange-brown and orange-red hues. The most distinct line in the blue at 450 nm results, without doubt, from the higher iron content. In every spectrum the Cr lines and bands are detectable, sometimes in considerable strength (doublet at 693 nm, etc.). The presence of vanadium in Tanzanian



FIG. 1. Survey of the most typical internal scene, pressure parting lines in Umba Valley sapphire of reddish-brown colour. 40x . (dark field illumination).



FIG. 2. Typical feather of crystallites, another common feature in reddish-brown sapphires of Tanzanian origin. 40x . (dark field illumination).



FIG. 3. Round zircon crystal with high relief, inside a sapphire from Umba Valley. 80x . (light-field illumination).

ruby, as indicated by Bosshart (1982), does not show up in the spectra of orange sapphire dealt with in this work. However, the rather weak and broad absorptions in the yellow and yellow-green are probably due to superposition of several absorption spectra (see again Schmetzer & Bank, 1981a).

Again, owing to the high iron content the stones were inert under both short- and long-wave ultraviolet radiations.

### INCLUSIONS

Various internal scenes were investigated in a large number of corundums having the body-colour mentioned. The most common and typical internal parageneses are shown as photomicrographs in Figures 1 to 3. The crystal inclusions were minute fragments or platelets in appearance. Most of the fragments showed the habit taken by apatite, but were too small for the exact nature to be identified. The feathers were often formed of minute crystals or were healed. Dislocations caused during growth were apparent in most of the specimens. This can be taken as an inclusion typical of the sapphires of this colour originating from Umba Valley.

### DISCUSSION

This new occurrence of reddish-brown sapphires from Umba Valley in Tanzania is another natural colour variety to the corundum family. The presence of the transition elements Fe, Cr and Ti along with certain growth defects cause the colour in these sapphires, and it should be mentioned that many intermediate colour hues may be presented in the trade, with false names such as 'padparadschah' or 'umbalite-sapphire'. However, the introduction of a separate name to this new find does not seem to be necessary. In future they can be called *reddish-brown sapphires*.

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## REFERENCES

- Amstutz, G. C. & Bank, H. (1977) Geologische, Petrographische und Mineralogische Beobachtungen in einigen Minen von Smaragd, Tansanit, Tsavorit und Rubin in Tansania und Kenya. *Z.Dt.Gemmol.Ges.*, **26**, 3, 118-27.
- Bank, H. (1978) Edelstein aus Kenya. *Z.Dt.Gemmol.Ges.*, **27**, 4, 185-95.
- Bosshart, G. (1982) Distinction of natural and synthetic rubies by ultraviolet spectrophotometry. *J.Gemm.*, **XVIII**, 2, 145-60.
- Dolenc, M. (1976) Das Tansanitvorkommen Merelani in Tansanien. *Z.Dt.Gemmol.Ges.*, **25**, 2, 86-95.
- Schmetzer, K. & Bank, H. (1981a) Die Farbursachen und Farben der Mineralart Korund. *Z.Dt.Gemmol.Ges.*, **30**, 3/4, 152-6.
- Schmetzer, K. & Bank, H. (1981b) The colour of natural corundum. *N.Jb.Mineral.Mh.*, **2**, 59-68.
- Schmetzer, K., Bosshart, G., Hänni, H. A. (1982) Naturfarbene und behandelte gelb und orange-braune saphire. *Z.Dt.Gemmol.Ges.*, **31**, 4, 265-81.
- Zwaan, P. C. (1974) Garnet, corundum and other gem minerals from Umba, Tanzania. *Script. Geol.*, **20**, 1-41.

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## FURTHER LIGHT ON THE SANCY DIAMOND

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Some years ago the late John Forster, one time chairman of the Gem Section of the London Chamber of Commerce and the sole remaining active director of the firm of James A. Forster & Sons Ltd, retired and at the that time passed over to me a very mixed assortment of gemmological specimens originally collected by his uncle, or great-uncle, a Mr A. A. Forster, towards the end of the last century. Among these was a very nice cut-paste replica of the Sancy diamond in a simple silver mount as a pendant. With it was a tattered and yellowing scrap of paper. These I now illustrate (Figure 1), and I think this note goes some way toward clearing up any mystery which may still surround the ownership of the smaller of the two Sancy stones.<sup>1</sup> The larger stone apparently passed into the ownership of the Maharajah of Patiala. Its present owner is not known.

1. See E. A. Jobbins, A brief look at the Sancy diamond, *J.Gemm.*, 1977, **XV** (5), 240-2; H. Tillander, Another brief look at the Sancy diamond, *J.Gemm.*, 1978, **XVI** (4), 221-8; Ian McGlashan, Letter to the Editor, *J.Gemm.*, 1981, **XVII** (6), 433-4; Corrigenda, *J.Gemm.*, 1981, **XVII** (8), 647.—Ed.