

PREFACE

Here at last is a comprehensive look at fabulous gemological wealth of East Africa. This unique region encompasses what may be the world's richest gem deposits. Kenya and Tanzania are revealed in their full mineralogical splendor for lapidaries, gemologists, collectors, travelers, and anyone with an interest in the world's gemstones.

Nearly all known species of important gems are found in this vicinity, frequently in abundant quantity, and essentially untapped. East Africa is quickly becoming a major source of rubies and sapphires.

In fact, with more than 40 varieties of gemstones from at least 60 known occurrences, East Africa is clearly among the richest areas, akin to Sri Lanka and Brazil, which interestingly, share a similar geology. It is rapidly becoming of major importance to the gem world.

Few, if any, areas of the world today exhibit more potential for gem riches than Kenya and Tanzania, known collectively as East Africa. Nearly all known species of important gemstones have been reported from East Africa, yet, to date, there has been very little systematic exploration for them. Historically in East Africa government-sponsored geological surveys for mineral resources have concentrated on the search for coal, tin, mica, salt, and gold.

In East Africa sporadic gem exploration has been done, however, usually as part of geologically mapping all of Tanzania by the government geological survey in the 1950s and 1960s. More recently, independent prospectors have scoured the countryside, particularly in northeastern Tanzania and southeastern Kenya, for an incredibly varied assortment of gemstones that are found in the area of very old high grade metamorphic rocks that geologists call the Mozambique Belt. The Mozambique Belt is known as the basement complex in Kenya and the Usagara in Tanzania, and consists entirely of Precambrian metamorphic rocks, mostly gneisses and crystalline limestone.

HISTORY OF CORUNDUM

Consider the stature of the corundum gems in the precious stone pantheon this is all the more amazing for together the ruby and the sapphire account for over 50% of the world trade in colored gemstones. Certainly it is not for lack of interest. The ruby and sapphire have long been considered among the most highly sought after and most precious of gems.

Next to diamond, corundum is the most important of all gem materials. The species name 'Corundum' however is relatively unknown to lay people. Much better known are varietal names of ruby (red) and sapphire (blue).

The name corundum is believed to be delivered from the Hindu word *kurand* (Streeter, 1892) or *kuruvinda* (Togore, 1879). This was the term used in India to describe

an impure form of corundum. Ruby means red, and is derived from the Latin ruber (red) though the late form rubinus (Smith, 1972). 'Sapphire' is a word meaning blue and when first used, described lapis lazuli. Its exact origin is unknown, but it may have come from Sanskrit originally. The word sapphire, of Greek word (Smith, 1972). A similar word is found in both Hebrew and Persian.

Today corundum is used to describe solely the mineral species consisting Aluminium Oxide crystallizing in the rhombohedral division of the hexagonal system. When pure, corundum is colorless, but this is rare. Impurities give rise to different color varieties, such as ruby (red = Chromium) or sapphire (blue = Iron + titanium). The term sapphire alone denotes a blue corundum, while for other hues, the color prefix is used – yellow sapphire, green sapphire, etc.

CHEMICAL AND PHYSICAL PROPERTIES

Classification :	Oxide
Composition :	Aluminium Oxide
Crystal system :	Hexagonal
Hardness :	9
Specific Gravity:	4.00
Refractive Index :	1.76-1.77
Birefringence :	.008- .010
Luster :	Vitreous

Chemically, corundum consists of crystallized alumina, eg aluminium oxide. All other elements within corundum reside as impurities. However, minute amounts of other elements, as impurities, allow corundum to take on a rainbow of colors. A few parts per million will give corundum its rich red color and a variety we know as ruby. Minute amounts of iron with chromium will give ruby a brownish overtone, common to Umba, Tanzania, rubies and sapphires as well as those from Thailand. The blue color most commonly associated with sapphire owes its pigmentation to a few parts per million of both iron and titanium. Without titanium, the sapphire becomes a golden yellow due to the remaining of iron.

Ruby and sapphire are second only to diamond in hardness, with a hardness of 9 of Moh's scale. They are however, four times softer than diamond. They most commonly occur as simple hexagonal prisms. Because of their hardness, both ruby and sapphire are useful to industry, and large nongem ruby and sapphire are crystals are commonly mined for use as abrasives. The relatively high specific gravity of corundum means that ruby and sapphire are heavier than most common minerals, a trait that allows corundum to be reconcentrated in stream gravels after being weathered and eroded out and can be mined in much more economical alluvial or placer deposits.

DEPOSITS

East Africa now has significant ruby and sapphire of its own. In 1973 an American geologist from the Massachusetts Institute of Technology, John Saul, discovered rubies near the junction of Bura and Mwatate rivers in the southwest corner of the Tsavo Game Park in Kenya. These rubies were readily accepted on the world market, and some even approached pigeon's blood color normally associated only with fine rubies from Burma.

Soon afterward, a second deposit, Penny Lane, was opened up nearby Tim Miller, another American geologist. These mines have had a checkered history due largely to political problems. Rubies of mostly an ornamental nature were known for many years from a deposit 150 miles to the northwest at Longido, in Tanzania. Recently, significant quantities of gem-quality ruby have been produced at Mahenge and Matombo in the Morogoro region of Tanzania, as well as in small, scattered deposits to the southwest. Rubies have also been produced for some time from the Lossogonoi area in Northern Tanzania.

The Uмба River drainage in the Tanga Province of northeastern Tanzania has produced some unusually fine sapphires in a host of colors as well as rubies. These gems owe their source to pegmatites in a small but very rich serpentinized intrusion on the south bank of Uмба River, just 50 miles southeast of the John Saul and Penny Lane ruby mines at Mangari in southern Kenya.

The entire region of Mount Kilimanjaro appears to be rich with ruby and sapphire. Even to the south at Matombo, south of Morogoro, significant quantities of gem-quality rubies have been mined; and in Kenya, at Kinyiki Hill, 5 miles north of Mtito Andei, near the Tsavo Game Park's main gate, sapphires are also mined. These sapphires originated from desilication of rafted gneisses in ultramafic serpentinite.

Finally, deposits that are only recently being examined near Lodwar on the west side of Turkana in northern Kenya appear to originate from alkalic basalt lavas. These sapphires have recently been reported in Kenya in the alluvium surrounding the Pelekech Range and the Murua Rith Hills. Other reported gem-quality ruby and sapphire deposits in East Africa include the Chania River, near Thika, Kenya; the Kwakonje area, Handeni district, as well as Mbinga district of Ruvuma, Tanzania; Kubi Kalo, near the Chanler's Falls area of Kenya; and West Pokot, Kenya.

RUBY- KENYA

Kenya is a land of fabulous game reserves and relatively liberal economy. It is also a land of untold gem wealth, much of it just beginning to be tapped. With the world's important ruby deposits numbering less than the fingers of one hand, the discovery of gem qualities in Kenya was important in its own right. However it was for an entirely different reason that the discovery made world headlines in 1974.

The ruby of Kenya are mined primarily in the Tsavo National Park region. Very little study has been done on these stones, which is unfortunate, for fine pieces are sometimes found. Most of the material from Kenya is suitable only for cabochons, and virtually all today is heat treated to improve the appearance.

Kenya rubies are noted for their fine red color and intense fluorescence, similar to many Burmes rubies, with which they are often confused. However, they can be easily separated from unheated Burmese stones because of the large numbers of liquid fingerprints and feathers which they contain. In contrast, Burmese rubies are normally quite deficient in liquid inclusions, except those that have been heated. Heat treatment introduces many fingerprints and feathers into Burmese rubies which are not found before treatment.

Rutile silk is not found in Kenyan rubies, so star stones are not produced. Kenyan rubies do, however, contain concentrations of minute exsolved particles arranged in patterns identical to rutile silk. Actual rutile needles, though, are absent. In some cases, these particles cannot be discerned. Instead, some show only diffuse white 'texture' clouds somewhat similar to those found in certain heat-treated blue sapphire from Sri Lanka. These texture clouds follow the hexagonal zoning of the crystal structure.

Color zoning is common and appears both as large diffuse zones and as sharp and narrow color bands. Rhombohedral twinning is also very common and is accompanied by long white boehmite needles along the edges and junctions of these planes.

Large numbers of liquid fingerprints and feathers are the hallmark of Kenyan rubies. Coupled with the clouds of exsolved particles, these features give a slightly turbid appearance to most stones, making them suitable only for cabochons. Even faceted gems generally possess this sleepy overall look, somewhat like 'Lai Thai' rubies but with extremely strong fluorescence. Many fingerprints appear thick and wispy, making confusion with the flux-grown synthetic products a very real possibility. However, appearing with the liquid inclusions are boehmite needles and lamellar twinning, allowing a separation to be made. In heavily included gems such as the Kenyan rubies, in order to examine a stone's interior it may be necessary to open the microscope's light source to light field and close the iris diaphragm until it is just smaller than the stone. Close examination of the liquid pockets of these fingerprints reveals a two-phase appearance in some cases. Others are seen to be tiny negative crystals which have resulted from the healing of cracks. Primary negative crystals are also found, both as well-formed individuals and as irregular cavities. These again may be confused with flux inclusions.

Sapphire in Kenya

Sapphire has been discovered in Kenya at a number of different locations. According to Pohl and Horkel (1980), sapphire was discovered in 1936 at Kinyiki Hill, which is near Mtito Andei, on the Nairobi - Voi highway. In 1936, corundum crystals approaching 1m in length were found. When broken up, small gemmy areas were found.

The sapphire occur in pockets with vermiculite and asbestos and are thought to have formed from desilication of gneiss at a serpentinite contact. Most production, however, has come from alluvial and colluvial deposits at the base of Kinyiki Hill. Production has said to be small and sporadic (Keller, 1992).

About 80 miles northeast of Mt. Kenya, at Garba Tula, are found dark blue sapphire of an inky color which strongly resemble those from Australia. It does not appear that these are being exploited, presumably because large enough quantities of facetable stones have not been found. Some fine yellow sapphires have also been recovered from this locality (Bridges, 1982).

In the mid 1980s, star sapphire from the area of Lake Turkana in northwest Kenya appeared in the local market (Barot & Flamini et al., 1989). Since that time, a quantity of both faceted and star blue sapphire have been mined. The material appears to be of volcanic origin, but the actual source rock is yet to be located. Some material improves with heat treatment (Barot & Flamini et al., 1989; Themelis, 1989b). Solid inclusions in Turkana sapphire include rutile silk, crystals of corundum and rutile/brookite. Color zoning is prominent. Most unusual are narrow planes of black hematite needles (Barot & Flamini et al., 1989; Hughes 1989).

RUBY AND SAPPHIRE - TANZANIA

The Kalalani area in Tanzania hosts several primary deposits of sapphire and the largest primary deposit of pyrope –almandine garnet in that country.

In 1989-1990, two significant discoveries of reddish orange ('Umba padparadscha') and yellow –brown sapphire were made in desilicated pegmatites that cross-cut a small serpentinite massif.

Local Geology: Corundum Deposits. Gem –quality sapphire and ruby are confined to desilicate pegmatites that cross-cut the serpentinite. They generally form lenticular (lens-like) bodies that are oriented vertically, and measure about 5-10m long and up to 2-3m wide. The dimensions are quite variable, since the pegmatites commonly pinch and swell. Like those at Umba, the Kalalani pegmatites are generally coarse grained and contain calcic plagioclase (andesine-labradorite) but no quartz. Other major constituents include amphibole, chlorite, biotite, spinel, corundum, and Kyanite.

The mineralized zones of the two pegmatites that yielded reddish orange and yellow-brown sapphire measured approximately 6m long and 2m wide. Although these pegmatites were only about 50m apart, they showed distinct differences. The reddish orange sapphire was mostly concentrated in patches of clay minerals within 'golden' yellow vermiculite and was accompanied by pink spinel (of low cabochon quality) as an important indicator. However, the yellow –brown sapphire was found within bluish green vermiculite, in the absence of clay and tracer mineral was spinel –pleonaste.

Ruby has been found at only two locations in Kalalani. At one of these, the senior author noted that tabular ruby was randomly distributed within biotite in a desilicated pegmatite, and accompanied by crystals of color-change sapphire.

HISTORY AND MINING

The history of the Kalalani area is closely associated with the nearby Umba River area, which has been described by Solesbury (1967), Dirlam et al., (1992), and Keller (1992). Although there are no official data on gem production from the Kalalani area, the senior author estimates that to date, the total production of fancy-color sapphire from the area is about 400kk. Thus far, less than 1 percent of this production has been faceted grade.

Sapphire and Ruby. The first organized mining of sapphire in the Kalalani area was by Umba Ventures Ltd, owned by George 'Papas' Papaeliopoulos, who developed three shallow open pits to explore pegmatites in the 1960s. Since then, the Kalalani area has been worked continuously by local miners who hand sieve the alluvial soil cover in search of fancy-color sapphire and ruby. Organized mining of primary deposits virtually ceased from the 1970 into the early 1980, when the original 'Papa' pit situated on the eastern border of the serpentinite, was reopened Ruvu Gem Ltd. At 40m, this is now the deepest mine in the Kalalani area. The serpentinite rock is very soft, and mining was carried out only by pick and shovel. A modified block mining method was used in the open pit.

During the time of greatest activity, in the mid 1980, about 30 people were involved in mining. Some cabochon-grade color-change sapphire was recovered, but transparent material was rare and the faceted stones seldom exceeded 1ct. Cabochon grade ruby (typically up to 0.5ct) accompanied the sapphire in places. Although Ruvu Gem ceased mining there in 1994, collector-quality sapphire crystals can still be found in the mine dump.

In August 1989, an important discovery of reddish orange sapphire was found in pegmatite dike at the Cham-Sham claim. The rights to develop this locality, as well as to explore the remaining part of the claim, were secured by V. Aslanyan of New York and H.D Patel of Dar es salaam.

Systematic trenching of this claim led to the discovery of yellow-brown sapphire in another pegmatite dike, in March 1990.

The transparent pieces of reddish orange sapphire seldom exceeded 3-5ct, although some cabochon-grade rough reached over 100gram of the approximately 80kg of reddish orange sapphire produced, about 1.5% was of excellent gem quality. A few of the stones were red enough to be considered ruby. The yellow-brown sapphire rough ranged up to 4-6ct, but clean, transparent rough reached only 2ct. About 100kg of yellow-brown sapphire were recovered, with less than 1% of gem quality. These were the only commercially significant sapphire finds in Kalalani over the past 30 years.

Gemstones from Kalalani are similar to those from Umba, which is well known for the production of sapphire in an unusually broad range of fancy colors-particularly the color-change and 'Umba Padparadscha' sapphires- as well as for light blue sapphire and ruby. While most Umba gems have been recovered from alluvium, gems at Kalalani are mined almost entirely from primary deposits.

The color change sapphire and characteristics inclusions of reddish orange sapphire from Kalalani are very similar to those from Umba, as well as to orange sapphire from the Tunduru area in southern Tanzania (Henn and Melisenda, 1997) and to orange sapphire from Malawi (Henn et al., 1990).

Although the traditional padparadscha sapphire from Sri Lanka shows more pink and less orange, some reddish orange sapphires from Kalalani have prominent pinkish tint. The visible absorption spectrum of the reddish orange sapphire from Kalalani is identical to that of similar material from Umba (as recorded by Hanni, 1987), and confirms the presence of Iron and Chromium as the main coloring agents.

On the basis of the studies of similar sapphire from Umba (e.g, Schmetzer et al., 1982), the reddish orange sapphire from Kalalani probably do not respond favorably to heat treatment, because color centers apparently are not present.

FUTURE POTENTIAL

The Kalalani area has never been systematically prospected, but there is some evidence that additional sapphire-rich pegmatites exist. Except for the old 'Papa' pits, mining generally has extended to an average depth of only 5-7m. Below this depth, there is high potential for the discovery of additional sapphires, and effort should be made to reach the deeper zones of abandoned deposits that were formerly productive.

The Kalalani area also has potential for other gem materials. The senior author has found green tourmaline in small pegmatite lenses hosted by quartz-feldspar gneisses southwest of the Kalalani massif. Also, small crystals of transparent green diopside have been recovered from fissures inside Kalalani massif

DISTRIBUTION

Most commonly , East African gems are first discovered and subsequently gathered on the surface by local prospectors or nomadic tribespeople, who then sell the rough stones in the closest local market.

This rough gem material may be purchased in small parcels that are generally sent to Nairobi where the stones may be cut. High- quality material is generally sent on the world market cutters in Germany and Thailand

CONCLUSION

However, Africa's street (or mountains) are not lined with gemstones. Africa is an example of extremes.

The inherent difficulties, in most of the mining areas, defy the imagination. These include anarchy, inadequate communications, difficult climatic conditions, poor infrastructure, insufficient finances, government red tape and arbitrary judgements, lack of technology and appropriate machinery, prevalence of malaria and other diseases, and in some areas warfare. As a result, the foreign investments that are sorely needed throughout Africa are difficult to obtain for colored gemstones mining. After discovery has been made, the systematic extraction of the gems present another set of problems. Once the easily accessible surface areas have been worked, hand mining becomes difficult, tenuous, and eventually uneconomical, at which time the area is abandoned. Restarting mining in a locality that has been desecrated by small-scale miners, even if modern machinery and mining methods are used, is usually economically unattractive.

Africa will almost certainly yield more compelling treasures in the new millennium, but the extent of its future gemstone wealth will depend on improvements in exploration and mining. And, although Africa is rich in colored gems, it is not likely that there will be an oversupply for an extended period of time and soon are exhausted. Thus Africa will be a reliable source of significant quantities of colored gemstones, but the supply will errate.

Bibliography

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