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ETHIOPIA: A NEW SOURCE FOR PRECIOUS OPAL

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Abstract

A new source for precious opal has recently been discovered near the village of Mezezo, Shewa province, Ethiopia. The opal is found filling lithophysae in a Tertiary welded tuff unit lying horizontally and extending for more than 15 kilometres. Claims have been filed on 2500 hectares covering the known opal-bearing area. About 1 per cent of the opal in the lithophysae has a play of colour, and much of the opal is crystal base. Refractive indices (1.439 to 1.448) and specific gravities (1.85 to 2.02) of the opal are similar to that of other precious opal from volcanic sources. Long term stability to cracking and crazing is not well established, but is expected to be similar to that of other volcanic opals.

Introduction

During a visit to his homeland in 1993, one of the authors (TZY) was given a broken lithophysae† nodule, about 3 inches (7.6 centimetres) across, containing fine crystal base precious opal. Recognizing it as fine opal, he inquired as to the location where it had been found. Fortunately, the description of the locality was sufficiently accurate that he was able to find the region, and discover a deposit of opal-filled lithophysae extending over a strike length of more than 15 kilometres. At the deposit, many lithophysae were weathering out of a glassy rhyolitic welded tuff as thin-shelled spheres of rhyolitic tuff completely filled with opal. The bulk of the filling is common opal, much of which is colourless and perfectly transparent. But about 1 per cent of the opal showed some degree of play of colour. The majority of the precious opal was semi- or crystal base. The potential for the deposit was immediately recognized, a company was formed for exploitation, and claims pegged.

This paper briefly describes the North Shewa deposit, based on preliminary exploration and development activities.

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Location and History

The deposit is located about 200 km NE of Addis Ababa, on the Ethiopian plateau in central Ethiopia, in the province of Shewa, near the town of Mezezo. The region is a high volcanic plateau, strongly dissected, with mountains over 4,000 metres (13,000 feet) in elevation. Because of the altitude, the climate is moderate for a region only 12 degrees north of the equator. The countryside is open savanna with low grasses and scattered trees, mostly of juniper species. Natives in the region raise a variety of pasture animals and cereal crops such as wheat, barley, corn, sorghum, etc. A typical family compound is shown in figure 1.

There is no known past production from this deposit, although local inhabitants were aware that opal was present. They, however, were not aware of its gem potential. Interest created by the recent prospecting activity has resulted in some local farmers illegally mining material readily accessible at the surface of this large deposit. Small quantities of this contraband have reached Europe and the United States through Nairobi (Koivula and others, 1994).

Although Africa is not known for precious opal, ancient natives made use of it to fashion artifacts — the source for which must have been somewhere in Africa. Dr. L. S. B. Leakey reported finding precious opal, jade, and quartz artifacts, which are dated at about 4000 B.C., in a cave near Nakuru, Kenya (Ball, 1939). Leakey believed that the source of opal was local.

Perhaps the source of these artifacts was the North Shewa deposit near Mezezo, for the Kushitic people (Barraclough, 1982), a group of stone age farmers, inhabited both regions at about this time. This supposition also raises new questions on the probable source of precious opal during the Roman Empire. Conventional wisdom (Leechman, 1961; Barnes and others, 1992; Bauer, 1904) assumed that the source was from the mines near Czerwenitza, Hungary, from where the opal was transported down the Danube River to Constantinople, and then

† Lithophysae - Hollow, bubble-like structures composed of concentric shells of finely crystalline alkaline feldspar, quartz, and other minerals found in silicic volcanic rocks.

‡ Ball considered both *opalus*, and *paederos* to be our present opal. However, see Thrupp (1987) for further comments.

westward to Rome. This assumption was principally based on the belief that no significant sources of opal exist in the regions reported by Pliny (Ball, 1950).

Pliny listed sources for *opalus*, and *paederos*‡ as the following: the best were from India, next Egypt, in third place, Arabia, and lesser quality from Natolia and Pontius. Pontius was part of present day Turkey, suggesting this lesser quality material may have been from the Hungarian source. Claudius Ptolemy (ca. 90-168 A.D.), in his famous *Geography* published during the 2nd century A.D., showed that the Ethiopian region was relatively well known at that time (Stevenson, 1932). The Ethiopian highlands, in which the Northern Shewa deposit is located, were then identified as the Garbatum Mountains. Trade in that opal could have gone down the Blue Nile to the Nile and then to Alexandria, or overland to one or more ports (Adulus, etc.) on the Red Sea, and then to Rome. These two hypothesised routes easily could explain Pliny's citing of India and Egypt as sources for precious opal of the first and second rank.

Geology

Rocks in the Ethiopian highlands are principally composed of intrusive and extrusive mafic Tertiary units of the Ashangi group. These consist of alkali olivine basalts and tuffs, doleritic sills, and gabbro-diabase intrusives. Rhyolitic units are subordinate. However, in the area where the opal-bearing lithophysae occur, rocks of the Magdala group predominate. These are upper Miocene to Pliocene rhyolitic to trachytic flows and tuffs, ignimbrites, agglomerates, and some basalts (Geological Survey Ethiopia, 1973). The detailed lithologies in the deposit area have not yet been carefully studied, or mapped, but some general features are evident. The lithophysae occur in a merocrystalline, porphyritic-vitric, volcanic welded tuff, lying approximately horizontal (Figs 2 & 3). Phenocrysts of quartz, potassium feldspar, chrysotile after olivine, and minor magnetite and biotite are present in the rhyolite. Glass comprises 95-97 volume per cent of the rock, and the phenocrysts comprise the remainder. Typically the tuff is light grey in colour, but may range to totally black. The lithophysal zone ranges from 3–5 metres in thickness with lithophysae comprising about 10 per cent of the volume. The lithophysae range in size from less than a centimetre, to over 15 centimetres (Fig. 4). The flat lying lithophysal zone, that occurs near the crest of ridges in this deeply dissected region, has been followed for over 15 kilometres. Test pits have been dug along the length of this lithophysal zone (Fig. 5). Claims covering 2500 hectares, that enclose the known lithophysae area, have been filed.

At the surface, the opal filled lithophysae weather out of the host rhyolite and are found scattered over the ground. The smaller nodules are remarkably spherical, while the larger ones tend to be slightly elliptical. They resemble the *thunder eggs* found in many similar volcanic terrains. Most show the familiar star shaped pattern of thunder eggs, with only a thin rind of rhyolitic tuff enclosing the opal filling (Fig. 6). Careful sampling at one site indicated 80 nodules per square metre at the face of the welded tuff host unit. About 10 per cent of the nodules are solidly filled, the remainder have either partial or no opal fill. Most of the filled nodules contain opal, although a few have been found containing agate.

The Opal Fill

Common opal, that fills the nodules, comes in a wide variety of colors such as colourless, white, brownish red, orange, yellow, greenish, pale lavender, and an unusual chocolate-brown (See figures 7 & 8). The opal may be opaque, or semi-translucent to transparent. Much of the material is transparent enough to provide good faceting rough, with some being reminiscent of red Mexican 'fire' opal.

Precious opal is estimated to be present in about 1 per cent of the nodules, but much of this opal has a weak play of colour. Body colour is similar to that found in the common opal, but no black opal has yet been found. However, better than 50 per cent of the precious opal is of crystal to semi-crystal type. The percentage of precious and common opal present varies considerably between nodules. Examples of some better grade nodules are shown in figures 9 and 10. Typically, the play of colour covers the spectrum in each piece. Green and blue or only blue play of colour are rare — but red is common. Pinfire patterns are rare, most examples show flashfire. This may reflect the very stable conditions within the nodules during the gelling and ordering phase of opal formation. In better quality material, the play of colour is evident over a wide range of lighting directions. However, in much of the jelly and crystal opal it is best displayed by lighting at near 90 degrees to the observer. This suggests that the opal spheres, comprising the precious opal, or the spacings between the spheres, are larger than is typical for Australian opal.

Some of the opal, both common and precious, has been found to be of the hydrophane type. This sticks to the tongue, and presents problems determining specific gravity by hydrostatic weighing. The hydrophane opal becomes more transparent when immersed in liquids. Some specimens of translucent precious hydrophane opal become completely transparent after soaking in water for an hour. After that time these opals lose most or all of their play of colour. They regain their fire after drying. Bauer (1904) reported a similar effect in some Hungarian opals, which may show no play of colour when first taken from the ground and are still wet — but develop fire after drying. Bauer (1904) also reported some Mexican opals from Queretaro may lose their play of colour, either becoming opaque or transparent with time.

Fig. 1. Family compound at the North Shewa opal field. Flatlying Magdala Group volcanics outcrop on ridge in the background.

Fig. 4. Selection of rough and cut nodules and pieces of Ethiopian opal.

Fig. 2. Nodule zone, high above the valley, appears as a light coloured zone trending vertically in the left quarter of the photograph, near the goats.

Fig. 5. Workers excavating a test pit on the opal horizon.

Fig. 3. View of a test pit showing a block of rhyolite with opal nodules.

Fig. 6. Opened nodules showing typical examples of rough precious opal.

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Gemmological Properties

Refractive indices, measured on 15 samples of the opal, ranged from 1.439 to 1.448 — with hydrophane the lowest (1.439 to 1.441). There was no apparent correlation between refractive index and colour, or transparency, based on this small number of samples. Specific gravities ranged from 1.85 to 2.02, with the hydrophane on the low side (1.85 to 1.87). During the hydrostatic weighing, this material absorbed about 2 per cent of its weight with water. The specific gravity for non-hydrophane material ranged from 1.99 to 2.02. Fluorescence generally was not present, however, a few samples showed a weak dull green to bright green under short-wave excitation. This response was due to the uranium content of these opals. They were all inert to long-wave ultraviolet illumination.

Characteristic Inclusions

Much of the material is remarkably free of any large inclusions. The most common inclusion consists of very small (~10 micron) opaque, reddish brown to brass-yellow 'dust' particles that are scattered throughout the opal. From their morphology and colour, the inclusions appear to be pyrite crystals, some of which have subsequently oxidized. These crystals appear to have grown within the gel, after it had formed, and when the gel was thick enough to prevent sedimentation of the dense pyrite.

Near the rhyolitic rind of some specimens, white to brown vermiform 'moss', which originates from the rhyolite, may be seen. On magnification, this 'moss' is seen to be growths of what Russian authors call 'membrane pipes' or 'tubes' seen in agates (See Godovikov and others, 1987, pp. 246-264 for details). These represent irregular branched growths of a slightly different refractive index. The 'tubes' may be opaque to transparent. Scattered along the walls of the 'tubes' are small cube-shaped red particles, that provide an outline of the tube position, and are presumed to be iron oxide pseudomorphs after pyrite. These pseudomorphs are typically larger than the 'dust' particles that are found in the bulk of the opal. These membrane pipes appear to be similar to "vein-like structures of unknown identity" from Yundamindera 'fire' opal described by Brown and Bracewell (1989).

At present the long term stability of this new opal is unknown. Only limited material from near the surface has been collected and worked to date, so that weathering has already taken its toll on this opal. As nights in the region are below freezing, these conditions have probably stressed many nodules due to alternating night-time freezing to day-time heating cycles. The deposit sits well above the water table in this region, a condition which has probably assisted in the slow partial dehydration of the material.

Fig. 7. Examples of rough and cut opal. The oval crystal cabochon measures 11x14 mm, and the freeform cabochon 17x18 mm.

Fig. 8. Chocolate base coloured precious opal rough.

Fig. 9. Example of a nodule with crystal base opal, measuring 5.2 cm.

Fig. 10. Two nodules showing a milky base colour: the upper nodule measuring 4.7 cm and the lower nodule measuring 6 cm.

Opal in the nodules is typically well fractured, normally yielding clean pieces of 1 to 2 grams. However, some solid pieces of as much as 40 grams have been obtained.

Crazing Potential

No major problems, such as fracturing or crazing, have occurred during the cutting of this material.A few stones have been held for over a year since cutting with no sign of crazing. The 'boiling kerosene test' described by Pearson (1985) was also used to help assess the crazing problem. Although this test was considered rather harsh for jelly/crystal opal - where heavy cementation between the silica spheres may trap pockets of free water - which, on heating to 180 °C in kerosene, could rupture the opal. Of four samples boiled for 25 minutes, as described by Pearson (1985), two were undamaged and two developed minor cracks, but remained intact. During examination of the samples, following the kerosene test, it was found that minute stress fractures, similar to stress fractures seen in heat treated corundums, developed around the dust-like pyrite(?) inclusions. Because these small stress fractures didn't propagate throughout the opal mass, that gives some added confidence that this Ephiopian opal material will be relatively stable.

Production and Mining Plans

Government regulations have limited opal production to acquisition of representative samples for testing and evaluation purposes, in advance of detailed mapping of the deposit, and filing of a formal development plan. The owners hope to complete government requirements during the summer of 1996, and to begin formal production soon after. Plans also call for establishment of a local cutting plant to process much of the commercial grade material in Ethiopia. However, early production will be sold in the rough in order to get sufficient material into the market to assess its acceptance and stability.

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