Blue sapphire from Malacacheta of Minas Gerais, Brazil

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Malacacheta, located in Minas Gerais, Brazil, is renowned for its alexandrite deposits and com-plex geological setting. Mining of alexandrite began in 1975, peaked around 1987, and contin-ued into the 2000s. Brazilian cat's eye alexandrite from this locality remains available in the mar-ket today. In addition to alexandrite, sapphires of various colors have also been reported from Malacacheta (Liccardo *et al*., 2006). However, sapphire has not been the primary focus of min-ing activity. These sapphires are recovered from the same alluvial deposits as alexandrite and are estimated to have formed in a metasomatic environment.

In this study, 13 faceted blue sapphire samples (Figure 1) from Malacacheta, commercially available on the market, were analyzed. According to the supplier, the sapphires were recovered together with alexandrite as a byproduct. The samples ranged in size from 0.35 to 0.69 ct and displayed colors ranging from light blue to vivid violetish blue, with some exhibiting visible color zoning. All samples were transparent, although some contained visible inclusions.

The sapphires exhibited gemological characteristics consistent with typical blue sapphire. Re-fractive indices ranged from 1.76 to 1.77, and specific gravity ranged from 3.98 to 4.00. Pleoch-roism ranged from pale to vivid blue. The samples were inert to both long-wave and short-wave UV radiation.

About microscopic features, most samples showed strong strain and color zoning (Figure 2). Comet tail-like inclusions were observed in some samples (Figure 3). Numerous samples con-tained crystal inclusions identified as plagioclase (Figure 4). Other mineral inclusions were rare; only one sample exhibited carbon and calcite inclusions within a surface-reaching cavity. Raman spectroscopy of a negative crystal inclusion (Figure 5) revealed CO_2 peaks at 1279.8 and 1384.6 cm^{-1} (Frezzotti *et al*., 2012). Additionally, no two phase inclusions were found in the samples.

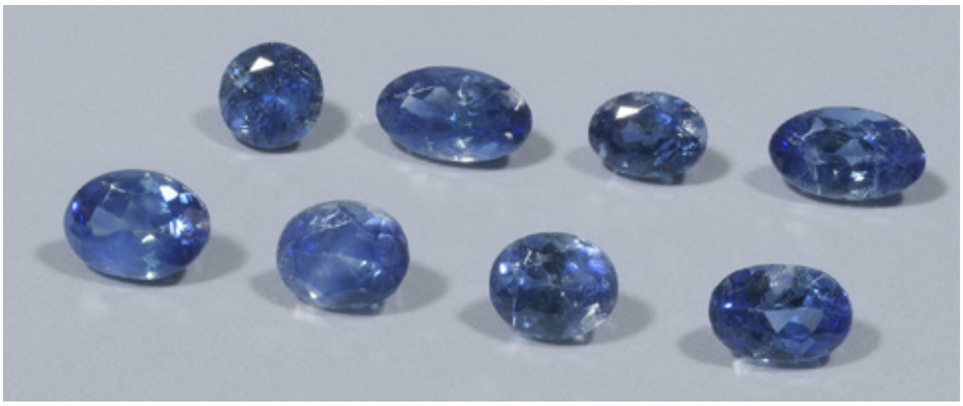

Figure 1. Tested samples of blue sapphire from Malacacheta

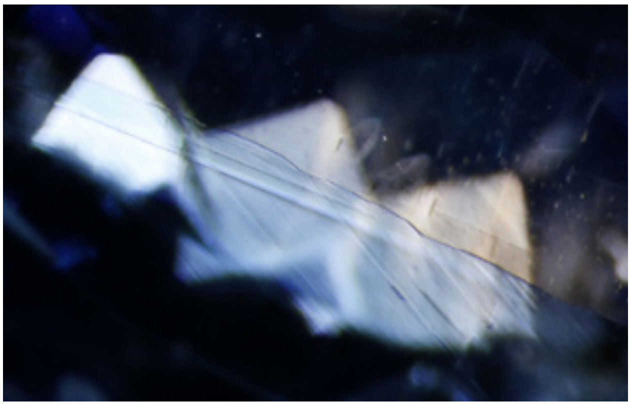

Figure 2. Strong strain with colour zoning

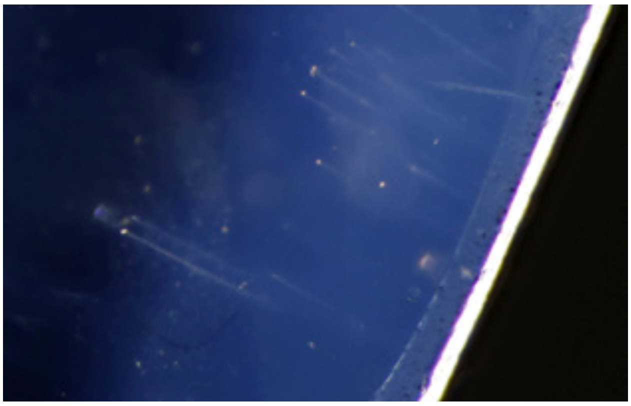

Figure.3 Comet like inclusions

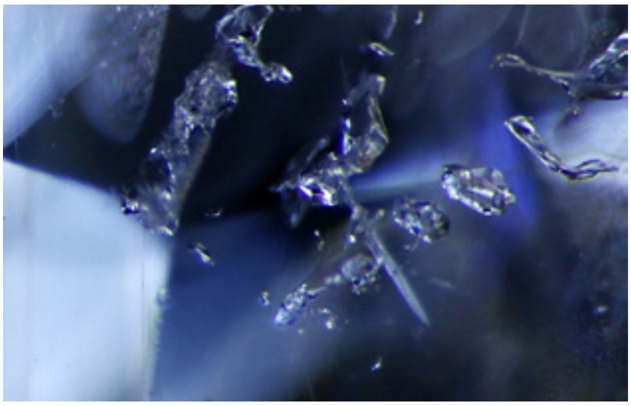

Figure 4. Plagioclase inclusion

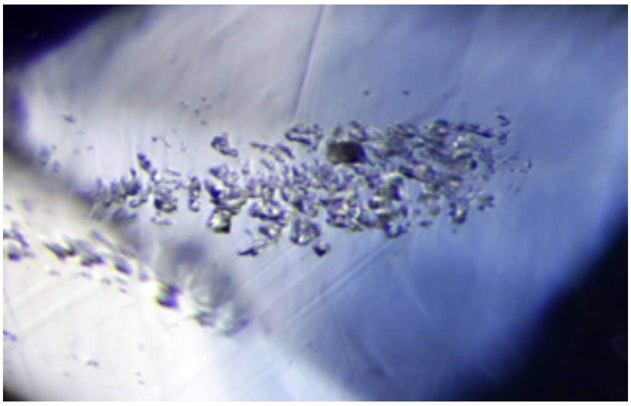

Figure.5 Negative inclusions tested with Ra-man

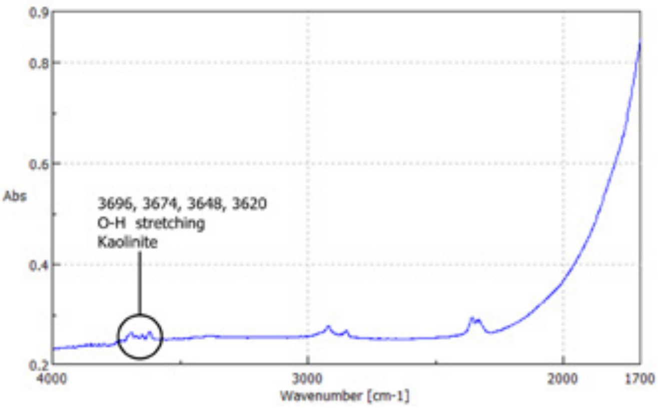

Figure 6. FT-IR spectrum with kaolinite absorption

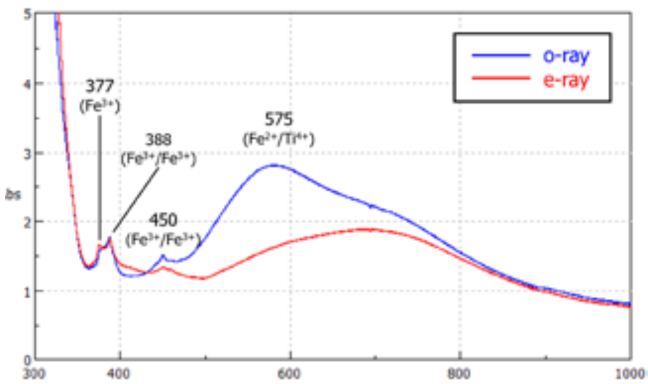

Figure.7 Polarized UV-Vis spectra

Origin	Malacacheta		Myanmar	Madagascar	Sri Lanka	Montana (Blue)
Elements	range	mean				
Be	0.2-3.1*	1.2*	-	-	-	-
Mg	41.9-138.4	81.5	25	63	63	37
Ti	127.2-608.5	320.2	59	164	138	50
V	8.7-30.5	20.3	1.5	23	9.4	5.2
Fe	1,845-6,393	3,722	2,040	924	997	4,598
Ga	53.7-124.0	83.0	89	63	97	54
Source	This study		Kreb, 2020			Zwaan, 2016

(*except high points)

Table 1. Trace elements of sapphire from Malacacheta and other origins (in ppmw)

FT-IR spectroscopy revealed almost no significant absorp-tions, except for weak kaolinite peaks in one sample. No OH-related absorptions around 3309 cm^{-1} were detected, not even as an al-most insignificant feature (Figure 6). UV-Visible spectroscopy indicated characteristics typical of non-magmatic sapphires, with no broad-band absorp-tion near 880 nm and a UV cut-off be-tween 320 and 330 nm (Figure 7). These features suggest a metamorphic origin and the absence of heat treatment under reducing conditions.

LA-ICP-MS analysis detected Be in all samples, with concen-trations ranging from 0.2 to 3.1 ppmw across most areas, and up to 6.8 ppm in specific regions containing cloud-like inclusions. High field strength elements such as Sn, Nb, and Ta were also detected in proportion to Be. Compared to the average trace element concentrations reported by Kreb *et al*. (2020) and Zwaan *et al*. (2016), the Malacacheta sapphires exhibited higher levels of Fe, Ti, and Mg than meta-morphic sapphires from Myanmar, Madagascar, and Sri Lanka. In particular, the Fe concentra-tions were similar to those found in Montana sapphires.

The Malacacheta sapphires are mined from alluvial deposit together with alexandrite. As the host rock for alexandrite formation in Malacacheta remains unidentified (Basílio *et al*., 2013), the exact origin of the sapphire is also uncertain. However, Basílio (2013) proposed that the alexandrite in this region formed via a Cambrian-aged metasomatic system, in which beryllium-rich fluids from nearby granite intrusions interacted with meta-ultramafic rocks and peralumi-nous schists. The features observed in this study—including strong strain patterns, CO_2 rich fluid inclusions and pla-gioclase inclusions, the absence of OH absorption in FT-IR spectra, and elevated Be, Fe, Mg, Ti concentrations—support the hypothesis that these sapphires might have crystallized in peraluminous schists and undergone metasomatic alteration by Be-rich fluids de-rived from granite intrusions.

References:

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