Peridot

(The Gem Darling of the Olivine World)

GEMSTONE ANDTEXTBOOK FORM PERIDOT FROM SAPAT GALI, PAKISTAN

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Introduction

Olivine and its subspecies peridot are important minerals with significant geological and economic importance. Olivine refers to a group of magnesium iron silicates that are a solid solution series of two minerals with one containing more iron (fayalite) and the other bearing more magnesium (forsterite.) Peridot represents the nearly pure magnesium (no iron) end member that is green and used as gems. Most gem material is currently being sourced from the Sapat Gali (Naran) area in Pakistan, the San Carlos Apache Reserve in Arizona USA, and from alluvial deposits in Myanmar.

History

Peridot jewelry from ancient Egypt is dated back to the second millennium BC and was considered a talisman to protect its wearer from the night and its horrors, being referred to as the "gem of the sun." The ancient source of this material was an island in the Red Sea called Topazios, now known as Zabargad / St. John's Island. Although this is mostly mined out, pieces and gems from this area are still in collections now. As with almost all gemstones, historically written accounts (even until shockingly recently) show deep confusion of gemology, mostly naming things based on color. This was particularly true of peridot and emerald.

Figure 1. St. John's Island in the Red Sea. It is about 2x3 km and clearly volcanic in origin

Chemistry

Olivine is a nesosilicate mineral where the silicate anion can combine with either magnesium or iron interchangeably. Therefore, its chemical formula is written as $(Mg, Fe)_2SiO_4$. Parentheticals represent that either the magnesium or iron cation may occur as perfect substitutions for each other without disruption of the mineral's structure. Although iron and magnesium may occur in any proportion (called a solid solution series,) the (theoretically) perfect end members fayalite and forsterite have different chemical and physical properties.

Figures 2 and 3. Fayalite (left) is often brown or black due to high iron content while the forsterite on the right is a gemmy green due to lack of iron. Left photo from Mindat.com and the right is a Jordi Fabre specimen and photo.

In general, fayalite is rich in iron which gives a dark muddy or opaque black coloring. It also imparts a lower melting point (1425° C) which means that it is stable in lower temperature rocks – often being found in basaltic rocks and sometimes in metamorphic rocks. It has a higher density and slightly lower hardness than forsterite. Forsterite, in contrast, has less iron grading all the way to peridot which has almost pure magnesium bound to the silicate anion. This causes it to be gemmy in colors from yellowish to grass green. It has a higher melting point (1890° C) and therefore largely found in ultramafic (ultrabasic)

rocks and within the Earth's mantle where there is immense heat and pressure. It has a Mohs hardness of 6.5-7 and a specific gravity of about 3.27-3.47

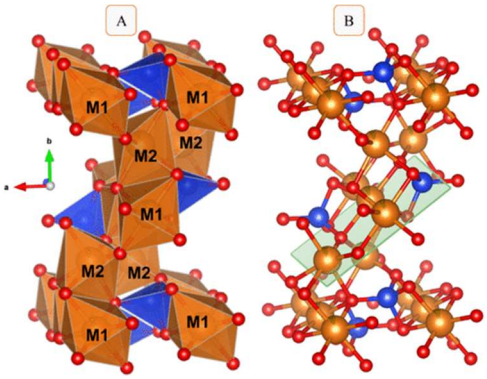

Figure 4. Ball and stick model of olivine. ACS Schematic.

Forms of Olivine and Peridot

Peridot is in the orthorhombic crystal system and often bipyramidal.

Figure 5. Textbook habit peridot from Moriarity's Gem Art

Figure 6. Variants of peridot crystals. Although the top peaked terminations are obvious, most peridot crystals show a rounding or softness of the edges and terminations

Figure 7 and 8. On left, a Burmese matched pair of peridot 15.83 tcw ond on right a Pakistan gem. Note that the Burmese gems are brighter with less yellow secondary color. This subtle color difference affects gem value

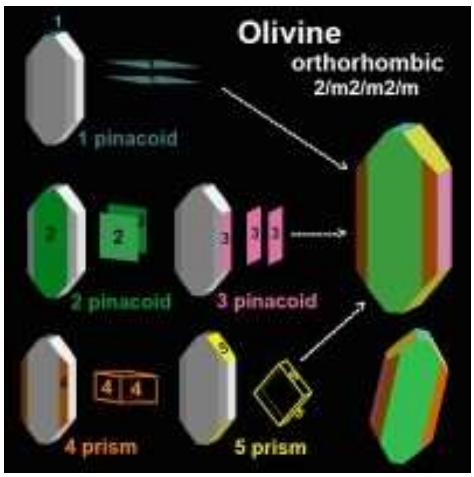

Figure 9. Smorf cartoon showing the typical habit of peridot. Notice how close figure 3 (right side) is to the theoretical form. Figure 5 is also similar with additional prism forms seen in the front prism. In figure 6, note how the left most crystal shows over development of the right sided prism face, causing an off-centered crystal.

Palladat Peridot

Peridot also is seen in extraterrestrial meteorites. Meteorites are rare in general and palladat meteorites are particularly rare. Forsterite olivine (peridot) occurs in a ground mass of nickel-iron that is more typical of meteorites. Meteorites are from planetoid remnants that have reached the earth's surface. They are thought to form at the interface of a silicate rich mantle and the metal (iron-nickel) core of the planetoid. The passing through the Earth's atmosphere creates unique and identifiable inclusions (stacked red platelets and high relief fingerprints) that confirm that the peridot is in fact extraterrestrial.

Figure 10 and 11. A nice slice of the Admire Meteorite (Kansas, 2009) showing backlighting of gemmy peridot in a silvery metal groundmass. KD Meteorites specimen and photo left. On the right is a 2.32ct faceted palladate peridot. GIA photo.

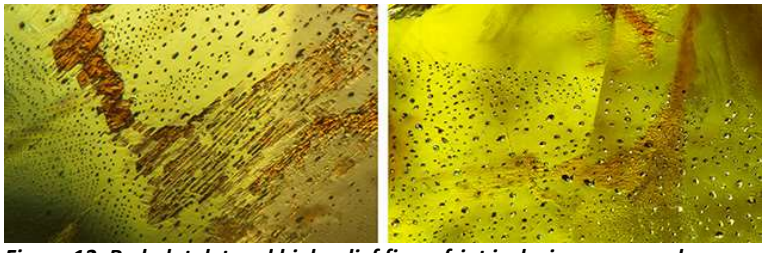

Figure 12. Red platelet and high relief fingerfrint inclusions seen under microscope indicating ET origin. GIA photos

Peridot from Sapat Gali, Pakistan

Located in the northern region of Pakistan, specifically in the Kohistan District of Khyber-Pakhtunkhwa Province, this difficult to access area has nonetheless been a significant source of gem and specimen peridot since the 1990s. This area is over 4,000 m above sea level, which is not only rugged but has a short summer and cold winters.

Figure 13. Sapat Gali in summer. The peridot mines are located near the tops of the mountains. Google Earth photo

As the Indian tectonic plate continues to collide into the Asian plate (the Himalayan Orogeny) outcrops of deep crust ultramafic rock is uplifted to the surface. The ultramafic rock is hosted by meta-gabbros and gabbro-diorites in an amphibolitic arc. The deposit itself is formed in serpentinized shear zones of dunite. Dunite is a rock composed almost completely of olivine, it has very little pyroxene in it (another ultramafic mineral group.). Serpentinization is a type of weathering where water interacts with ultramafic rocks to create a host of by-products, including talcs. Because of the serpentinization, many specimens are covered in an adherent white talc, which is usually cleaned off with a water jet gun before sale. Many of the crystals are included with ludwigite as black needles or sprays. They can form with black cubes or dodecahedrons of magnetite

Figure 14. Dunite- an ultramofic olivine heavy rock. Geology. com

Figure 15. Peridot with magnetite in adherent talc (serpentinized material) Gandhara Gems specimen and photo

Figure 16. A nice peridot crystal heavily included by ludwigite which can be seen as black sprays running from left to right. They are so heavy as to occlude the color of the peridot. E-rocks photo

Figure 16. A well formed and fully gem crystal of peridot from Sapat Gali. Mineral Mike specimen and photo.