Olivine – Peridot
橄欖石

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Fig. 1 Peridots rough and cut, from various locations. Photo © H.A.Hänni

作者詳述了寶石級橄欖石的特性，它歸屬於橄欖石類礦物，它有三種成因，化學成分的改變而引致顏色、折射率和比重的變異，並簡報其內含物、人工合成方法和產地，以及作為首飾時應注意的地方。

Peridot is a widely appreciated green gemstone (Fig. 1). It belongs to the Olivine group, which also includes the major minerals forsterite Mg_2SiO_4, fayalite Fe_2SiO_4 and tephroite Mn_2SiO_4. Olivines are the main constituents of mafic and ultramafic rocks that are formed in the earth's mantle. Olivine-basalt rocks bring the crystals to the surface, where they are found e.g. in extended basalt layers such as in China (Hebei province) (Fig. 2), and the USA (Arizona). Another genetic type of olivines is found in rocks formed by metamorphism like in Myanmar or Pakistan. Olivines are also the main constituents of rare pallasites, nickel-iron meteorites, with large inclusions of olivine (Fig. 3). Synthetic forsterites with dopants are used for laser technology applications.

Fig. 2 An olivine-basalt rock sample with olivine grain clusters and a larger olivine crystal from Zhangjikou-Xuanhua, Hebei Province, China. Photo © H.A.Hänni

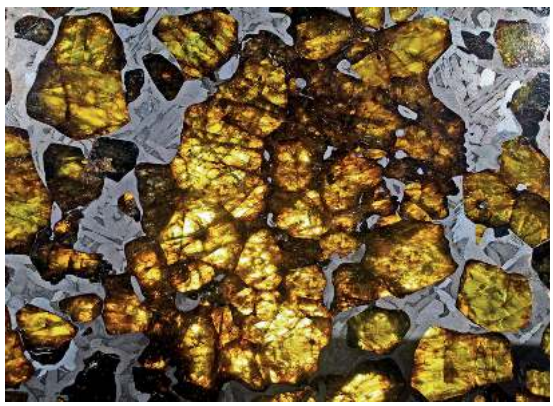

Fig. 3 A Pallasite, an iron-nickel matrix with olivine crystals. Photo © H.A.Hänni

Gemstone olivine is called peridot, and also chrysolite. It is represented by a solid mixture between the Mg member forsterite (fo) and the Fe member fayalite (fa), with high fo and low fa concentrations. Occasional contributions of Mn, Ni or Cr are always very small, but influence the colour of the stone. Forsterite and fayalite are a solid solution series just as pyrope and almandine garnets. Colour and physical data depend on the mixing

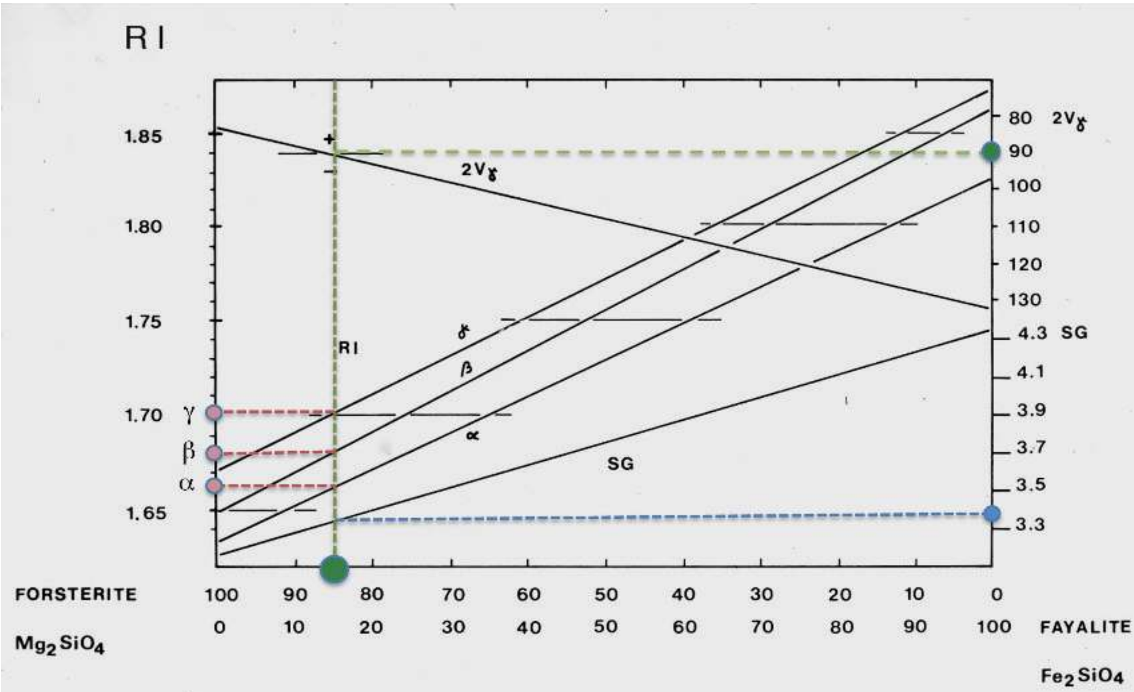

Table 1 A diagramme of the Forsterite-Fayalite solid solution series relationship Mg – Fe replacement with refractive indices, density and optical axial angle. Diagramme after Deer, Howie & Zussman, 1992.

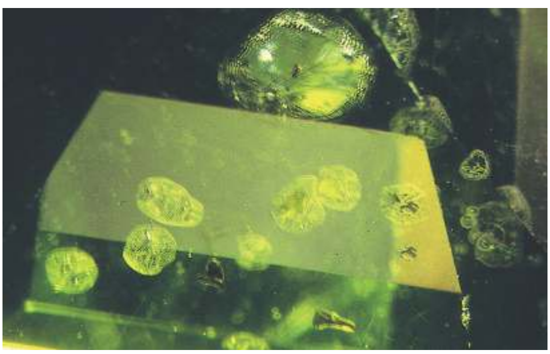

Fig. 4 Typical discoid fissures (lily pads) around tiny inclusions in a peridot from Arizona, USA. Width of image 4.5 mm. Photo © H.A.Hänni

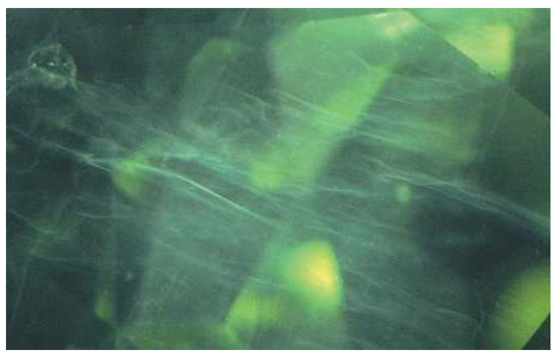

Fig. 5 Milky veils, probably a transition from olivine to serpentine in a peridot from Myanmar. Width of image 2.5 mm.
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ratio. Iron (fa) increases refractive indices and specific gravity. While pure forsterite is colourless, fayalite is brownish green. Peridots with attractive colours take a position between fo95-fo85 and fa5-fa15 within the series. Higher iron contents spoil the nice colour and turn it into a brownish olive. Table 1 shows the relationship of mixing ratio and optical/physical data. For fo85-fa15 the position is indicated with a green dot. The density is 3.34 (blue dot). Refractive indices for this composition are indicated with pink dots. The angle between optical axes is very large with peridot, 90° (olive dot, upper right), as seen on Table 1.

Fig. 6 Synthetic forsterites produced by Solix, Belarus. Stone on left is 12 mm long. The Cobalt blue sample is sold as an imitation of Tanzanite.
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Looking deep into a peridot with a microscope, we can see a number of phenomena. As the bi-refringence has a value of 0.035, most directions of observation show us a strong doubling of back facets, or inclusions. A very typical inclusion is the lily pad. This consists of a central small inclusion, fluid or chromite grain, surrounded by a fine roundish plane fissure, often with some radial ribs (Fig. 4). In some peridots we find single crystals or clusters of black octahedral minerals, usually from the chromite / chromian spinel group. As many peridotite rocks undergo metamorphism with the presence of water, they may end up as serpentines. In many gem peridots we may see whitish veils, bringing some turbidity into the stones (Fig. 5). This turbidity shows the start of the transition of olivine to serpentine.

Fig. 7 A faceted peridot before and after a bath in warm sulphuric acid.
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Solix in Belarus has produced colourless synthetic forsterite (Fig. 6). Cr-doped forsterite is used mainly for laser crystals. But they also produce Co-doped forsterite that resembles tanzanite in colour and pleochroism. As dopants are only present in small concentrations they have little effect on the RI and SG; the material is thus easily identified as forsterite.

Peridot is widely used in jewellery; from small stones from basaltic deposits to large and beautiful crystals, some even over 100 cts. Other sources besides China, the USA and Pakistan are Burma, Tanzania and to a few others. There are vulnerabilities that the jewellers working with this stone must take into consideration. Peridot is very easily etched by sulphuric acid in the pickling solution used after soldering on peridot jewellery. Even 5 minutes in a warm acid bath will etch the stone's surface so that it becomes matte (Fig. 7).

References

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Deer, W.A., Howie, R.A. & Zussman, J. (1992). An Introduction to the Rock-Forming Minerals, Second Edition, Longman.