Iridescent andradite garnet from Tenkawa, Nara Prefecture, Japan

Sachio Ohtaki[1]; Norimasa Shimobayashi[2]; Akira Miyake[1]; Masao Kitamura[3]; Yusuke SETO[1]; Kenji Tsuruta[4]; Jo-ji Sugimori[5]

[1] Earth and Planetary Sci., Kyoto Univ.; [2] Dept. of Geol. & Mineral., Kyoto Univ.; [3] Dept. Geology and Mineralogy, Kyoto Univ.; [4] Kyoto City Un. Arts; [5] A

Iridescent garnets were first found at the Adelaide mining district, Nevada and described by Ingerson and Barksdale (1943). They are extremely rare and have been reported from only a few localities in the world, but not a few studies were carried out to examine origin of iridescence; for example, andradite garnets from Adelaide by Hirai and Nakazawa (1982, 1986) and Akizuki et al. (1984); from Kamihogi, Yamaguchi Prefecture, Japan by Akizuki et al. (1984); from Sonora, Mexico by Bader and Akizuki (1997). However, the origin of iridescence is still far from being well understood. Recently, one of the present authors (J. S.) found enormous volume of iridescent samples of andradite garnet from near Kose mine, Tenkawa, Nara Prefecture, Japan. In the present study, textures of this newly-found 'Super Rainbow Garnet' are first explored by using optical microscopy, SEM-EDX and TEM.

Iridescent andradite from Tenkawa, Nara Prefecture, occurs in skarn accompanying with hedenbergite and magnetite as brown translucent euhedral crystals with well-developed {110} faces about 1 cm across. Greenish schiller is noticeable. The specimens used in this study were collected by one of the present authors (K. T.). Polarizing microscopic observation of some specimens revealed that Tenkawa garnet consists of well-developed {110} sectors without {211} sectors, whereas {211} sectors were observed both in Kamihogi and Sonora garnets.

A crystal of the garnet was cut perpendicular to the [001] axis through its center. The average chemical composition is And96.0Grs3.3Sps0.7. In the (001) thin section, several {110} sectors were observed and the banding texture parallel to {110} faces was observed in each sector. Strong iridescence was observed in four sectors – (011), (-101), (0-11) and (101) sectors, whereas iridescence was not observed in the other four – (110), (1-10), (-1-10) and (-110) sectors. In the latter four sectors, {110} layers are perpendicular to the thin section, and therefore parallel to the transmitted light. This fact suggests that the interference of light with {110} layers originate the iridescence. Each sector in the (001) thin section shows a repetition of straight and {110} bandings with and without wavy lamellae. The banding texture looks like the oscillatory zoning as described by Akizuki et al. (1984) and Hirai and Nakazawa (1986). There are, however, no significant chemical variations in the present specimen and the width of the straight lamellae varies 170 to 300 um. Therefore, they should be growth band. The latter wavy lamellae with chemical difference correspond to the moire-like texture as described by Hirai and Nakazawa (1986). The thick lamellae brighter in BEI are 10 to 20 um in width, and the darker thin lamellae are 1-2 um. The chemical compositions are And97.0Grs2.3Sps0.7 and And91.3Grs8.0Sps0.7, respectively. However, the periodicity of more than ten microns of these lamellae is too large in comparison with the wavelength of light and cannot be origin of iridescence.

After optical microscopic and SEM observations, the (011) sector in the same thin section was thinned by ion milling. Fine lamellar texture can be observed within the wavy lamellar zone with TEM. The layer texture was found to be composed of alternating major and minor lamellae with very sharp interfaces between the adjacent lamellae. The major lamellae are 100 to 300 nm in thickness and the minor lamellae are about 20 nm. The origin of the fine lamellar texture is probably exsolution as proposed by Hirai and Nakazawa (1986) or oscillatory zoning by Akizuki et al. (1984). In either case, it is no doubt that iridescence of the present Tenkawa garnet should be due to these fine {110} layer texture.