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Gem garnet in pegmatites from Neelum valley, Azad Kashmir

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ABSTRACT: *The upper Neelum valley is occupied by a group of basement rocks of Precambrian to early Paleozoic age and a cover of younger rocks. Both the basement and cover contain Late Paleozoic(?) mafic sheets. There are at least two sets of pegmatites, one pre-dating and the other post-dating the mafic sheets. A few of these contain green tourmaline, pink beryl, and colourless topaz. One of the pegmatites near the village of Phullawaii contains bluish green tourmaline and gem garnet. The garnet is well-formed and reaches up to 30 g in weight. It is clear, transparent, takes a good polish, and ranges from yellowish red to tangerine and crimson red. Many spots analysed in two tiny (<0.5 cm²) grains are uniform in composition. The garnet is rich in spessartine (79.9 mole %), with small amounts of almandine (15.3 mole %) and grossular (4.4 mole %) components.*

INTRODUCTION

Many gemstones, occurring in a variety of geological environments, have been reported from the Himalayan region of northern Pakistan. Kazmi et al. (1985) described several gemstones, including garnet, from granitic pegmatites in the Nanga Parbat massif. Pegmatites containing garnet, tourmaline, and transparent quartz also intrude the Precambrian basement and cover rocks in upper Neelum valley. Here we report on a pegmatite which contains a good quality, spessartine-rich garnet in this area of Azad Kashmir.

GEOLOGICAL SET-UP

The northern part of Azad Jammu and Kashmir is occupied by a series of phyllites, schists, gneisses, quartzites, marbles and related rocks collectively named as Salkhala Series by Wadia (1934). Recent studies have shown that the upper Neelum valley is occupied by a group of basement rocks of Precambrian to Early Paleozoic age and a cover of younger rocks (Malik 1995). The basement, which has also been referred to as the Higher Himalayan Crystallines, can be further divided into two major components (Butt, 1992). One of these is made up of a migmatite complex comprising psammitic, pelitic, and calcareous metasediments intruded by preponderant granitoids. The other component is a group of well-bedded rocks dominantly consisting of garnet- and plagioclase-bearing semipelites, and intruded by amphibolite sheets. This group may be younger than the migmatites. Both of these contain local eclogites.

The Phullawaii village is located on the basement but not far from its contact with the cover (Fig.1). The basement and intrusive rocks here can be divided into:

1. Sillimanite granitic gneisses, medium- to coarse-grained, with feldspar augens, and con-

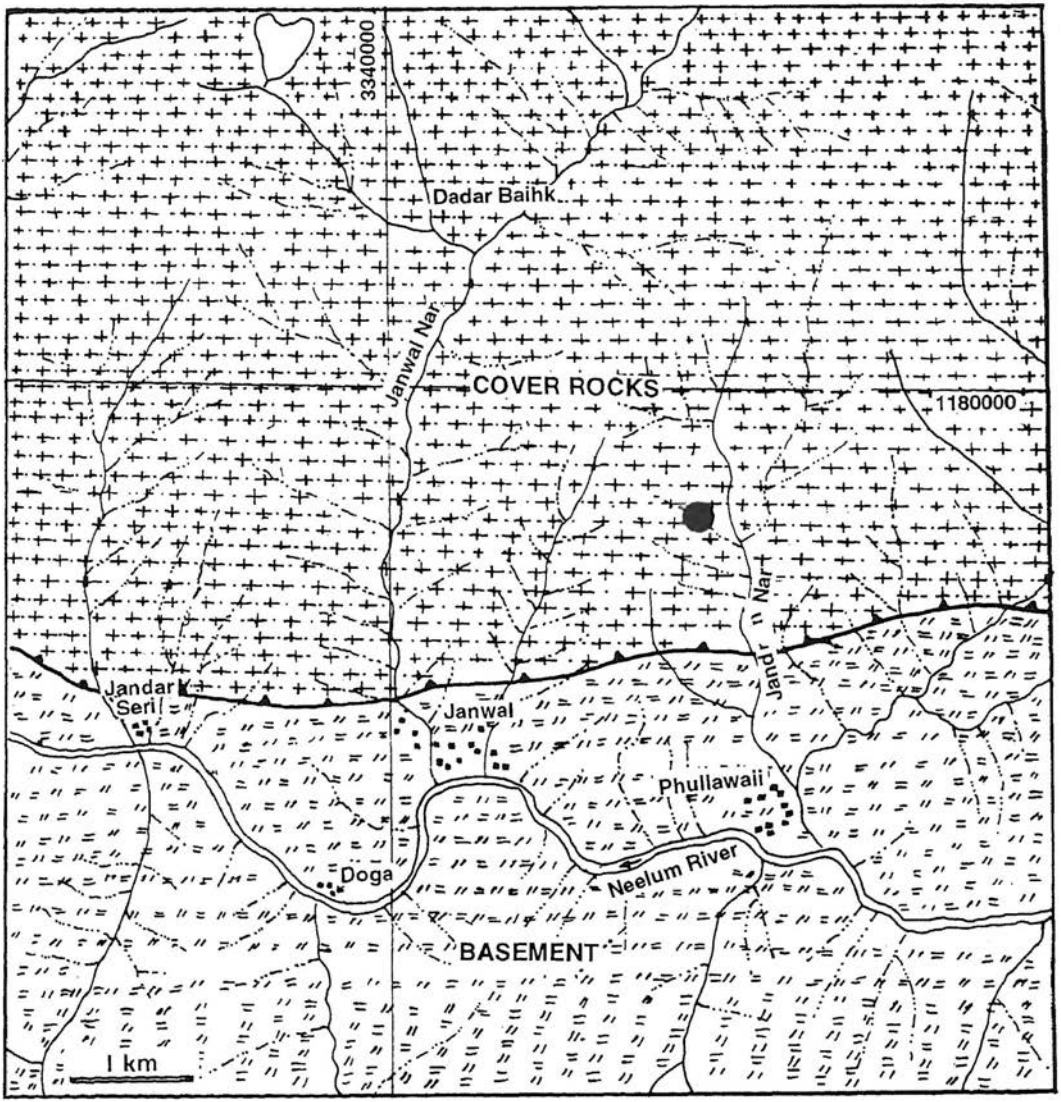

Fig. 1. Geological map of Janwai-Phullawaii area of the upper Neelum valley, Azad Kashmir . Dot shows the location of the pegmatite containing gem garnet. (Modified after R. M. Nasim Khan). The basement consists of sillimanite-garnet-biotite schists, gneisses, and granitic rocks, and the cover is mostly made up of garnet-mica schists, marbles, and impure quartzites. Both contain mafic sheets.

sisting of mica-garnet-sillimanite-quartz-feldspar-black tourmaline.

2. Sillimanite-garnet-biotite schists, containing also feldspar and quartz and displaying medium- to fine-grained texture. These occur in discontinuous layers interbedded with other units, are well-fractured and intruded by pegmatites.
3. Sheet granite. Interbedded with other units, there are fine- to medium-grained sheets con-

sisting of feldspar, sillimanite, quartz, biotite, garnet, kyanite and black tourmaline (Butt, 1993).

The basement is apparently thrust over the cover. Compared to the basement, the cover rocks display longer lateral extent and have also been subdivided into two sequences. One of these comprises marbles (± ruby corundum), calcareous rocks and quartzites. The other sequence contains graphite-bearing garnet-mica schists, plagioclase- and garnet-bearing paragneisses, and impure quartzites (Schoupee et al., 1992).

Both the basement and cover rocks of the area are intruded by mafic sills and dykes which may be related to the Late Paleozoic Panjal episode. These sheets are more commonly intruded where the host rocks are well-jointed or structurally undulated. At a number of places, the various rock units are also intruded by pegmatites, locally in swarms. There appear to be at least two sets of pegmatites, one pre-dating and the other post-dating the mafic dykes. Seven of the pegmatites inturding the schists of the cover sequence are being explored for garnet and other material (i.e., green tourmaline, gem-grade morganite (pink beryl), colourless topaz, lepidolite). The most promising of these is described in the following.

THE GEM-GARNET PEGMATITE

The Jandaran Nar area is located close to the contact of the basement and cover sequences. The lithological units near the contact comprise well-bedded sillimanite-garnet-mica schist overlain by sillimanite-garnet gneiss. The schist shows recumbent folds and a mafic dyke has intruded the central part of the folded area of the unit near the village of Phullawaii. Both of these have been intruded by the so-named Jandranwala pegmatite (Malik, 1995). It occurs as a tabular body at an elevation of 2,590 m above sea level. The exposed body is 15 m in length and attains a maximum thickness of 4 m in the central part where it cuts the mafic dyke sharply. Towards the pinching ends, it intrudes the schists. The pegmatite occurs 1.5 km NE of Phullawaii, some 200 km NE of Muzaffarabad (74° 33' 16" E, 34° 48' 30" N). The mafic dyke is a porphyritic rock consisting of plagioclase (zoned andesine), clinopyroxene (subophitic), amphibole, biotite and apatite. The analysis of the rock suggests it is basaltic andesite. This, coupled with its undeformed fabric, suggests that it may be younger than the Panjal sheets.

A good mineralogical and textural zoning has apparently developed in the pegmatite. Near the mafic dyke it is fine-grained aplitic, and contains a higher concentration of tourmaline. The intermediate part is medium- to coarse-grained. This contains well-developed crystals of K-feldspar with minor quartz and yellowish green tourmaline. Euhedral to subhedral crystals of garnet are disseminated in the pegmatite. The core zone of the pegmatite is characterized by a coarse-grained pegmatitic fabric and a high concentration of quartz. Some of the quartz crystals here weigh over 40 kg. The feldspar shows cavities locally containing bluish green semi-gem quality tourmaline crystals. The pegmatite is apparently underformed, raising the possibility that it was intruded after the Early Tertiary tectono-metamorphic episode that affected the NW Himalaya of Pakistan.

THE GEM GARNET

The garnet occurs in potash feldspar and shows a higher concentration in the intermediate zone, towards the fine-grained margin adjacent to the mafic dyke. As such the occurrence is similar to the granitic pegmatites of the Nanga Parbat massif in the Indus gorge section. These contain, among other gems, garnet and tourmaline which at least in some cases are concentrated in a zone

adjacent to the marginal aplite (see fig.3 in Kazmi et al., 1985).

The garnet forms well-developed, euhedral to subhedral crystals reaching up to 30 g in weight (Fig. 2). Some 40 kg of gem-grade garnet has been mined since early 1994. Of this, 50% is suitable for faceting and cabochan. Many of the fashoned stones are more than 10 ct in weight. The stones are transparent and range in colour from yellowish red to tangerine and very appealing crimson red. Macroscopically, the good quality specimens do not show flaws (i.e., fractures, inclusions, alteration, colour variation), and can be cut into excellent gems. Under the microscope, some of the grains display brown stains along fractures. In a few, tiny specks of black granules were noted and, in rare cases, there are trails of clear, tubular inclusions up to 0.03 mm in length. Under crossed polars, the specimens are perfectly isotropic, but show internal growth zoning.

The garnet has a density (hydrostatically determined) range of 4.15 to 4.23, a hardness of about 7.5, and refractive index of about 1.80. It shows typical spessartine absorption spectrum with bands at 410, 420 and 430 nm. Electron microprobe analyses suggest that it is essentially spessartine (79.9 mole %), with small amounts of almandine (15.3 mole %) and grossular (4.4 mole %). The Mn-rich garnet of the Indus gorge, according to Peters and Lindsley (1988), consists essentially of spessartine (70 mole%) and almandine (28 mole%).

Seven representative analyses of two garnet grains are shown in Table 1. The polished surfaces of the grains are less than half a square centimeter in area. The garnets are apparently uniform in composition. All the analyses contain trace amounts of uvarovite and schorlomite components, but no pyrope and andradite. There is an excess of Si in Z and deficiency of R^{3+} and R^{2+} cations in Y and X sites, respectively. This may either be due to a lack of analysis for other elements or to an over-estimation of SiO_2.

One of the analyses (No.7) is different than the rest in that it shows a higher amount of spessartine (84.6 mile%) and lower almandine (10.2 mole%). This appears to be a faulty analysis because it contains a much higher amount of Si (in Z) and a lower amount of R^{2+} cations (in X) than those required stoichiometrically. But it is interesting to note that the end-member contents of this analysis are identical to those (spessartine 85.3%, almandine 10.1%, grossular 4.6%) reported by Henn (1996) for a garnet from this area.

Fig. 2. Right: Pegmatite hosting spessartine garnet some 2.5 cm in the longer dimension.
Left: Specimens of gem-grade garnet the largest of which weighs 9 g.

TABLE 1. MICROPROBE ANALYSES OF GEM GARNET FROM NEELUM VALLEY

	1	2	3	4	5	6	7	Mean
SiO_2	36.09	37.12	36.45	36.03	36.02	37.11	38.04	36.47
TiO_2	0.04	0.10	0.10	0.00	0.10	0.06	0.08	0.07
Al_2O_3	19.81	19.89	20.05	21.04	20.67	20.09	20.91	20.26
Cr_2O_3	0.15	0.07	0.01	0.09	0.04	0.00	0.00	0.06
FeO	6.50	6.10	6.26	6.88	6.45	6.66	4.07	6.48
MnO	32.02	34.79	33.81	31.82	33.56	34.33	33.39	33.39
MgO	0.01	0.00	0.00	0.05	0.00	0.00	0.00	0.01
CaO	1.52	1.65	1.64	1.30	1.58	1.75	1.56	1.57
SUM	96.14	99.72	98.32	97.21	98.42	100.00	98.05	98.31
				CATIONS BASED ON 24 (O)				
Si	6.116	6.103	6.070	6.024	5.991	6.085	6.231	6.065
Ti	0.005	0.012	0.013	0.000	0.012	0.007	0.009	0.008
Al	3.956	3.854	3.934	4.146	4.052	3.883	4.038	3.970
Cr	0.020	0.009	0.001	0.012	0.006	0.000	0.009	0.008
Fe	0.921	0.839	0.871	0.962	0.897	0.913	0.557	0.901
Mn	4.596	4.844	4.768	4.506	4.727	4.768	4.632	4.702
Mg	0.001	0.000	0.000	0.012	0.000	0.000	0.000	0.002
Ca	0.276	0.290	0.292	0.232	0.282	0.307	0.247	0.280
Z	6.12	6.10	6.07	6.02	6.00	6.09	6.23	6.06
Y	3.98	3.88	3.95	4.16	4.06	3.89	4.06	3.99
X	5.79	5.97	5.93	5.71	5.91	5.99	5.46	5.88
Alm	15.9	14.0	14.7	16.8	15.2	15.2	10.2	15.3
Spes	79.3	81.0	80.4	78.9	80.0	79.6	84.6	79.9
Gro	4.2	4.4	4.6	3.8	4.3	5.0	4.8	4.4
Sch	0.1	0.3	0.3	0.0	0.3	0.1	0.2	0.2
Uva	0.5	0.2	0.0	0.3	0.1	0.0	0.2	0.2

Analysis 1–3 from one, and 4–7 from another specimen. Anlysis 4 contains 0.2 mole % pyrope. Mean excludes analysis 7.

In conclusion then, there are undeformed granitic pegmatites of possible Himalayan age in the Precambrian basement of upper Neelum valley. Gem quality, spessartine-rich garnet in one of these near Phullawaii is encouraging. Further search in this rather difficult area may reveal additional occurrences.

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REFERENCES

Butt, K. A., 1992. Petrography and ore microscopy studies on gemstone and base metal occurrences in Azad Kashmir. Unpubl. rept. UNDP/UNDESD Project PAK/86/019, AKMIDC. Muzaffarabad, Pakistan.

Henn, U., 1996. Spessartine aus Pakistan. Zeitsch. Deutch. Gemmol. Gesell., 45(2), 93-94.

Kazmi, A. H., Peters, J. J. & Oboda, H. P., 1985. Gem pegmatites of the Shingus-Dusso area, Gilgit, Pakistan. Mineral. Rec., 16, 393-411.

Malik, R. H., 1995. Geology and resource potential of Azad Kashmir ruby deposits. In: Proc. Ntnl. Conf. Foreign investment in Explor & Mining in Pakistan. Govt. of Pak., Islamabad, 153-171.

Peters, J. J. & Lindsley, R. L., 1988. Pakistan garnet compositions. Mineral. Rec., 19, 128-129.

Schuppee et al., 1992. Progress report of Surgon-Gumot area. Unpubl. rept. AKMIDC, Muzaffarabad, Pakistan.

Wadia, D. N., 1934. The Cambrian-Trias sequence of north-western Kashmir (parts of Muzaffarabad and Baramula districts). Rec. Geol. Surv. India, 68(2), 121-176.