Geol. Bull. Univ. Peshawar, Vol. 37, pp. 167-178, 2004

Gems and gem-bearing pegmatites of the Shigar valley, Skardu, Northern Pakistan

M. HASSAN AGHEEM[1], M.TAHIR SHAH[1] & TAHSEENULLAH KHAN[2]
[1]National Centre of Excellence in Geology, University of Peshawar
[2]Geoscience Laboratory, G.S.P., Shazad Town, Islamabad

ABSTRACT: *Shigar valley, due to various semi- precious gemstones, is one of the most important valleys of the Baltistan in the northern areas of Pakistan. The gemstones mostly concentrate into the pockets or cavities of the zoned pegmatitic dikes or veins. The pegmatite bodies are intruded into the metasediments and meta- igneous rocks of the Karakorum Metamorphic Complex (KMC) and are considered as part of the Karakorum Axial Batholith.*

The gemstones occurring in the pegmatitic bodies of the Shigar valley include: aquamarine, colorless to yellow topaz, green fluorite, tourmaline (schorl), garnet, fluoroapatite, morganite, goshenite, epidote, quartz etc. These gemstones are present into the cavities or pockets in the coarse- grained zones of the pegmatitic bodies. Internal structure, texture and mineralogy of these bodies are variable at different localities of the valley. Tourmaline (schorl) is ubiquitous in the entire gem- producing localities, while other gemstones are specific to certain localities. This suggests the role of variable geochemical conditions/parameters during the formation of gemstones within these pegmatites.

INTRODUCTION

Shigar valley is famous for the occurrence of various gemstones. Shigar is located about 32 km northeast of Skardu, the headquarters of Baltistan. The valley is accessible by a metalled road from Skardu to the proper Shigar and the rest of the valley is generally manageable by Jeep (Fig. 1).

The valley is characterized by the rocks of both the Karakorum plate and the Kohistan- Ladakh island arc (KLIA) with the intervening northern or Shyok Suture Zone. These rocks are mainly metasediments and metaigneous, along with pegmatitic dikes, belonging to the Karakorum Metamorphic Complex (Desio, 1963; 1964; 1979; Searle et al., 1986; 1989; Searle, 1991; Searle & Tirrul, 1991; Hanson, 1989; Fraser et al., 2001). Considerable work has been done on various units of this complex from tectonic, structural and metamorphic point of view) but very little work has been done in regard to the gem- bearing pegmatitic dikes and veins. The gem-bearing pegmatite dikes and veins are exposed at different localities of both the Shigar as well as the Braldu Rivers at high altitudes. The dikes and veins vary both in length and in width and are generally zoned. The gemstones are present into the cavities or pockets in the walls and intermediate zones. This paper is the general introduction of the gems and gem-bearing pegmatites of the Shigar valley, based on the field data.

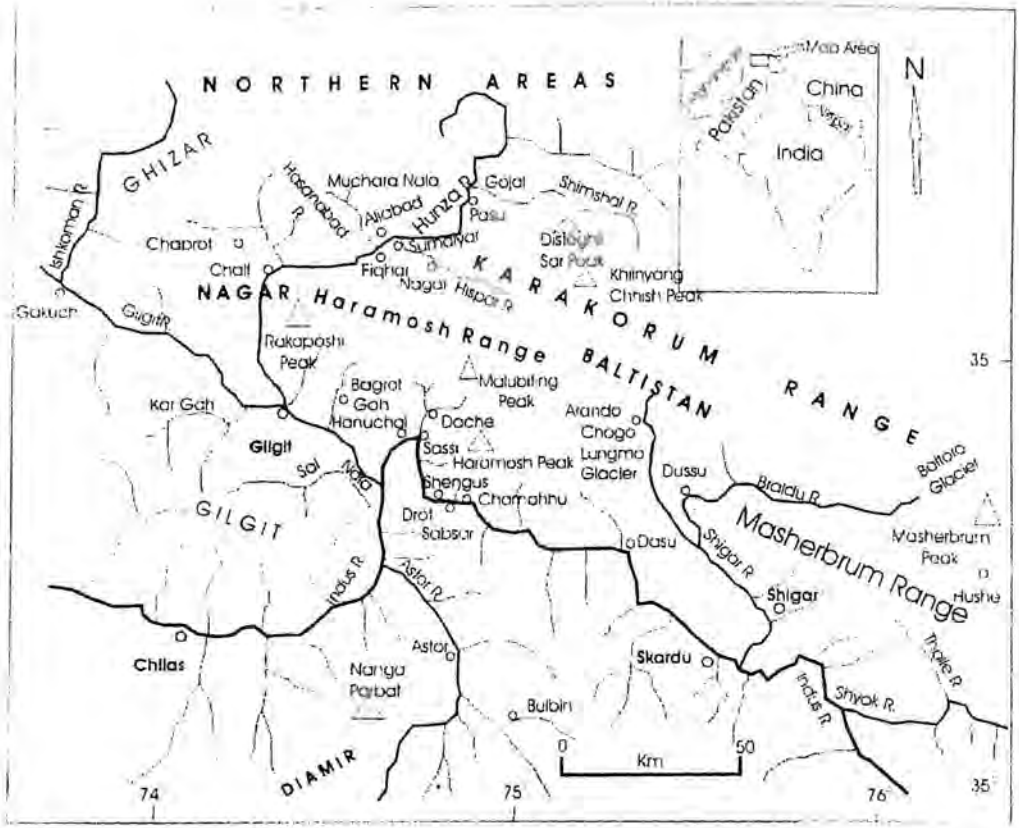

Fig. 1. Location map of the Shigar valley in northern regions of Pakistan.

GEOLOGY OF THE AREA

The Northern Areas of Pakistan consist of three geological domains, namely 1) Indo-Pakistan plate, 2) the Kohistan-Ladakh island arc and the Asian plate (including the micro-Karakoram plate).

Shigar valley occupies partly the southern margin of the micro-Karakorum plate and partly on northern margin of the Kohistan- Ladakh island arc. Main Karakorum Thrust (MKT) or the Northern Suture Zone (NSZ) is passing from the center of this valley. The rocks of the micro-Karakorum plate are thrust over the metasedimentary and metaigneous rocks of the Kohistan-Ladakh island arc. Igneous activity of various episodes also occurred in this region and its surroundings and as a result various small and large plutonic bodies of pre- and post collision are exposed on both, the north and south of the Shigar valley. In addition to this, the metavolcanic rocks of the Rakaposhi Volcanic Complex of Tahirkheli (1982), locally known as Shigar volcanics are also present in the valley. The plutonic rocks have been metamorphosed to amphibolite facies on both sides of the suture zone except the late stage pegmatites. The rocks within one km of the suture zone are highly fractured. Serpentinite pods are also exposed in the vicinity of the suture zone near the village of Hashupa.

Various workers have recognized different lithologic units in the Shigar valley. The oldest rock sequence in this valley is the Daltumbore Formation, which belongs to the Asian plate. This formation is mostly composed of interbedded clastic and carbonate metasediments and is faulted southward along the Northern Suture over the Bauma- Harel formation of the Kohistan-Ladakh island arc (Hanson, 1989). Earlier Desio (1963) divided this formation into three units but later on Hanson (1989) described this formation as one unit, having an age of Permo-Carboniferous (Hanson, 1989).

Dassu gneiss, earlier named as granodiorite augen gneisses by Desio (1963) is another unit of the Asian plate exposed near the Dassu village in the Shigar valley. It consists mainly of quartz- K- feldspar, plagioclase, biotite and garnet.

Two Katzarah and Bauma-Harel formations along with some isolated deformed granodiorite of the Kohistan- Ladakh island arc are present in the Shigar valley. The Katzarah formation is an extensive unit of high-grade metasediments, exposed in the Indus valley and in the lower Shigar valley. Desio (1963) called different parts of this formation as Tsordas gneiss, the Skoyo gneiss, the Askole amphibolite, and the Katzarah schist, but Hanson (1989) put all these units together and called them as Katzarah formation.

The Bauma-Harel formation of Cretaceous age consists of volcanoclastic sediments that have been metamorphosed to chlorite-epidote green-schists and are interbedded with slates, phyllites, and minor carbonate layers Desio (1963). The contact between the Katzarah formation and the Bauma-Harel formation is depositional rather than tectonic whereas the northern suture is present on the northeast side of the Bauma-Harel formation. The volcanics of this formation are correlated with the Rakaposhi Volcanics of Tahirkheli (1982).

GEM- BEARING PEGMATITES OF THE SHIGAR VALLEY

In Northern Areas of Pakistan, the pegmatites (both gem- bearing and barren) have been known from various localities (Kazmi et al., 1985; 1990; Laurs et al., 1996; 1998; Searle, 1991). The majority of the gem-bearing pegmatites is related either to the Ladakh intrusives such as the gem-bearing pegmatites of the Stak Nala and Shengus or to the Main Karakorum Batholith such as the gem-bearing pegmatites of the Shigar valley, Hunza valley, and the pegmatites of the Masherbrum and Hushe areas etc.

The Shigar valley is unique in the sense that a variety of gemstones is found from the pegmatites of this valley. The pegmatites of the Shigar valley generally exposed near the village of Mungo or Haiderabad extend to Yuno along the Shigar River and from Dassu to Goyungo along the lower Braldu River (Fig. 2). The pegmatites of this area are diverse and different not only in mineralogy but also in internal structure, dimension and thickness. The pegmatites are ranging in thickness from 1 m to 2 to 3 m and length up to 4 km. Majority of the pegmatites in the area is zoned but some unzoned pegmatites are also present. Some pegmatites have symmetrical zoning (i.e. repetition of same zone on both the sides of the dikes or veins) (plate 1).

The studied pegmatites with four zones have the outer aplitic zone, the wall zone with feldspar $\pm$ two mica $\pm$ quartz, the coarse-grained intermediate zone with variable mineralogy (the zone of gem-bearing pockets or cavities) and the core with large quartz crystals. Besides, the thickness of the dikes

and veins, the internal zones of these bodies are also different in thickness. In some dikes or veins the outer aplitic zone is about 2-5 cm whereas in others it is almost absent. The major zone of these pegmatites is the intermediate coarse-grained zone, having pockets or cavities of variable sizes, which hold various gemstones (Plate 1). These pegmatites vary in thickness (<6 cm to 3 m) and length (<50 to 2 km). The pegmatite dikes of maximum thickness (>3 m) and maximum length (~2 km) have been noticed near the villages of Goyungo and Haiderabad respectively (Plates 2 and 3). In addition to aplitic-pegmatitic dikes, leucogranitic dikes are also exposed in the area, especially near Dassu and to the upstream of the Braldu River. These dikes are absent along the course of the Shigar River and are generally devoid of gemstones.

The pegmatitic dikes usually cross cut the foliation planes and have parallel to sub parallel orientation. These pegmatitic dikes are generally undeformed, which indicate that these bodies have escaped from the major multiphase regional deformation and metamorphism. Due to the presence of rocks of entirely different tectonic regions (i.e. the Karakorum plate and the Kohistan- Ladakh island arc) in the study area, the host rocks of these pegmatites also varies in their mineralogy and grade of metamorphism.

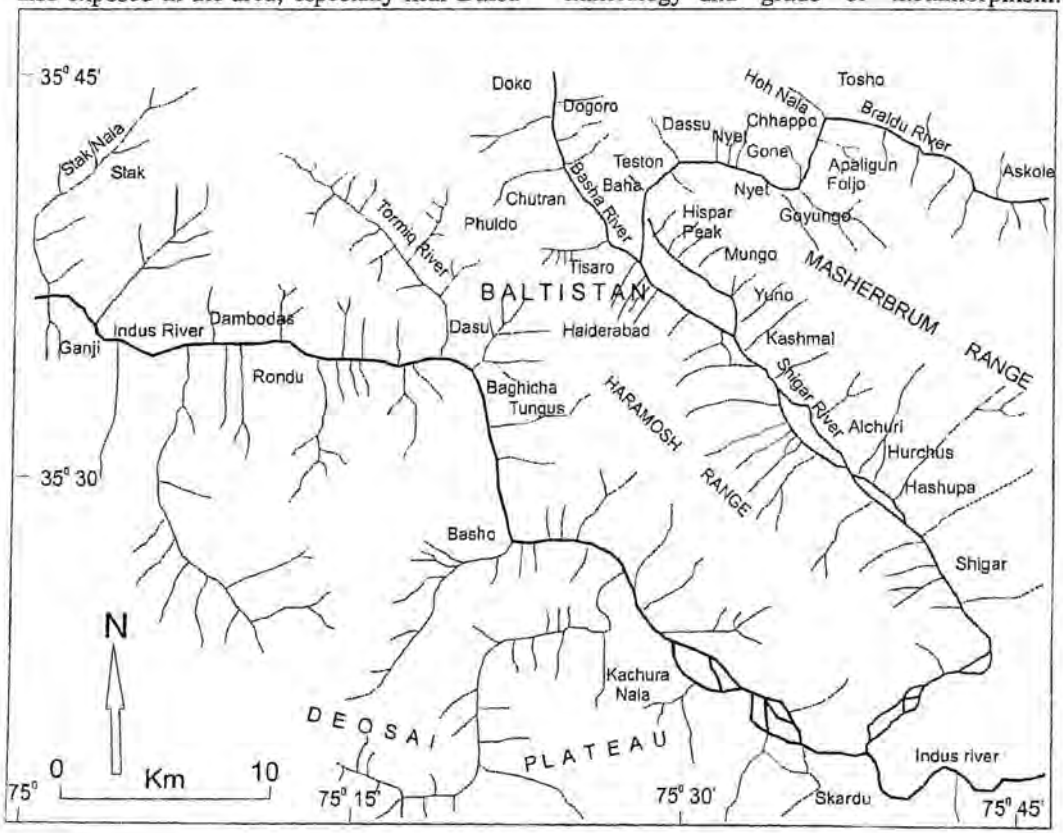

Fig. 2. Different localities of the Shigar valley, where gem-bearing pegmatite dikes and veins are exposed.

Plate 1. Symmetrical pegmatite dike showing the contact with the Augen-biotite gneisses, the host rock. The dike is cross cutting the foliation planes of the host rock. Zoning in pegmatite dike is visible. There is marginal thin aplitic zone (< 2cm), followed by inner coarse-grained zone (≅8cm) and medium-grained zone (≅5cm). Muscovite flakes < 5 cm are also visible as patches within the pegmatites.

Plate 2. Pegmatite dike (≅2m thick) within the Para gneisses near the village of Goyungo along Braldu River. This dike has been mined by the local people where from tourmaline, aquamarine, beryl, topaz and large crystals of quartz had been excavated.

Plate 3. Pegmatite vein/ dike (about 2 m thick) and extending to a distance of >400m along the road, near the village of Haiderabad. These pegmatites attained yellowish-brown weathered surface due to iron leaching close to biotite. Schorl crystals are well seen throughout the dike, however, few small crystals of beryl are also noticed.

However, these rocks have been named as Karakorum Metamorphic Complex by Searle (1991) and Searle et al. (1989 & 1991). Among these rocks the Dassu biotite gneisses are exposed near Dassu and extended up to the Goyungo village. The other metasediments and metaigneous rocks of the Daltumbore and Bauma- Harel formation are exposed along the northeastern side of the Shigar River in the study area.

Beryl (aquamarine) and tourmaline (schorl) are the ubiquitous gemstones occurring in the pegmatites in Shigar Valley but some gemstones (e.g., epidote, sphene (titanite), yellow apatite, diopside, goshenite, manganotantalite) are confined to certain localities.

GEMSTONES OF THE SHIGAR VALLEY PEGMATITES

Like the internal structure and other characters of these pegmatitic bodies, the mineralogy of these dikes and veins is also diverse and variable at various localities of the Shigar valley. Quartz, alkali feldspar and plagioclase in variable proportions constitute the bulk mineralogy, however, muscovite, biotite and gem- quality minerals such as beryl (aquamarine), topaz, garnet, fluorite, apatite, goshenite etc are present as accessories.

The following descriptions and photographs of various gemstones are based on the field data and the information taken

from the local people and the miners in the Shigar valley. The detailed mineralogy of the pegmatites and qualitative and quantitative analyses of these gemstones are under completion and will be published elsewhere.

Beryl (aquamarine) [$Be_3Al_2Si_6O_{18}$]:
Transparent and colourless to pale blue aquamarine crystals (5-15 cm x 1-7.5 cm) for the first time reported by Middlemiss and Parshad (1918). According to Kazmi et al. (1985) aquamarine crystals up to 16 cm long and 7 cm wide from Dassu pegmatites have been reported in the James A. Gibbs Collection. Transparent to translucent aquamarine crystals (Plate 4) ranging in size from 2 cm to 12 cm are common. These are usually associated with albite and tourmaline (schorl), but at some places calcite has also been noticed in association with aquamarine as matrix material.

Gubelin (1981) reported goshenite, a colourless to white variety of beryl, from the pegmatites of the Dassu area. The beryl and its varieties are present in the vugs or cavities within the coarse-grained zone of the studied pegmatites.

Fluorite (CaF_2)
Light to dark-green coloured fluorite (Plate 5) is present in the pegmatites in Yuno, Nyit Bruk, Mungo, Kashmol, and Baha in the Shigar valley. The average size of these crystals is generally 2x3 cm and are usually associated with muscovite, biotite, tourmaline and topaz.

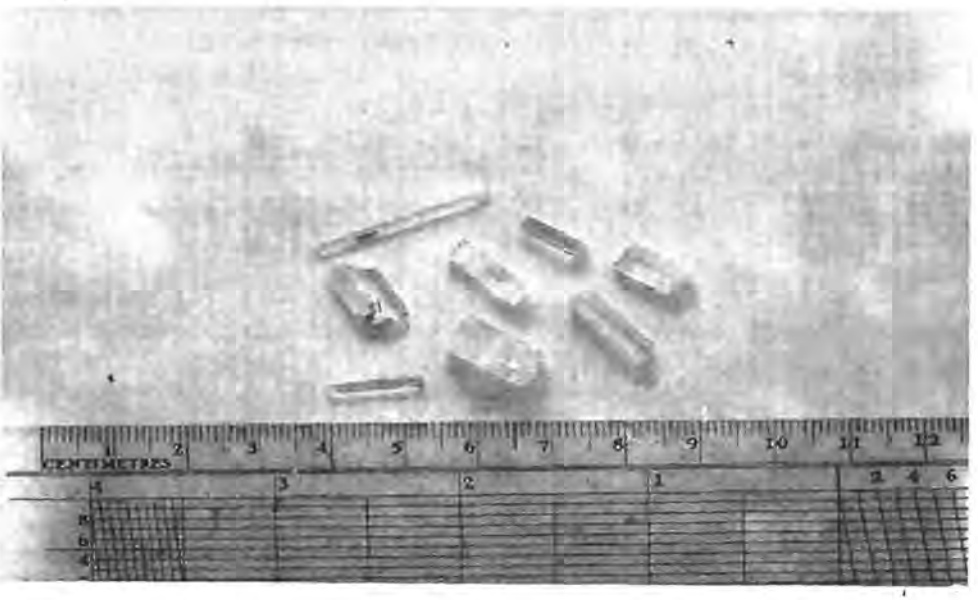

Plate 4. Colorless and transparent aquamarine crystals with rectangular prismatic faces from Yuno, Shigar valley. These crystals vary in size from 1 to 3 cm.

Plate 5. Light-green coloured fluorite crystal (2cm across) from Yuno, Shigar valley.

Almandine Garnet

Although garnet is present in pegmatites at various localities of the Shigar valley but gem-quality almandine-garnets ranging in size from < 1 cm to > 2 cm are present in the pegmatites in the Dassu area (Plate 6). These are translucent and reddish brown in color.

Hydroxyl-Herderite [CaBe (PO_4) (OH)]

Kazmi et al. (1985) have reported that a single specimen of hydroxyl- herderite, crystallized within the pegmatites from Dassu area is preserved in the American Museum of Natural History Collection (AMNH 15604). The colour of this specimen is apple-green and the size is about 2.5 cm. The common associations to this crystal are pink fluorapatite and white albite.

Manganotantalite ($MnTa_2O_6$)

Dark- reddish black, stratiated crystals have been reported by Kazmi et al. (1985) from the pegmatites of the Dassu area. These minute crystals (up to 5 mm) are enclosed within aquamarine crystals. Besides, Dassu, manganotantalite has also been found from Mungo area during this study.

Schorl [$NaFe_3^{+2}Al_6(bO_3)_3Si_6O_{18}(OH)_4$]

Schorl, black colour tourmaline, is ubiquitous phase of all the pegmatites of the Shigar valley. It occurs both in the form of clusters and also as disseminated crystals in all the pegmatitic bodies of the Shigar valley. The sizes of these crystals are variable. One from the pegmatite of Hashupa village measured as >4 cm long and >1 cm wide was collected (Plate 7). Numerous striations are present on the long prismatic faces of the crystals. Good specimens are associated with aquamarine, microcline, albite, muscovite and quartz in the studied pegmatites.

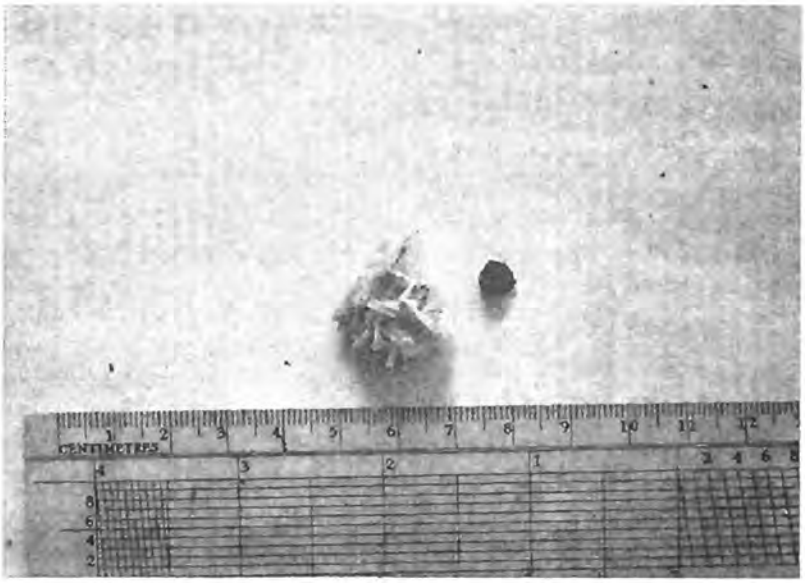

Plate 6. Reddish brown almandine garnet (small grain) from Yuno area. White colored calcite crystals precipitated as amorphous phase is also visible.

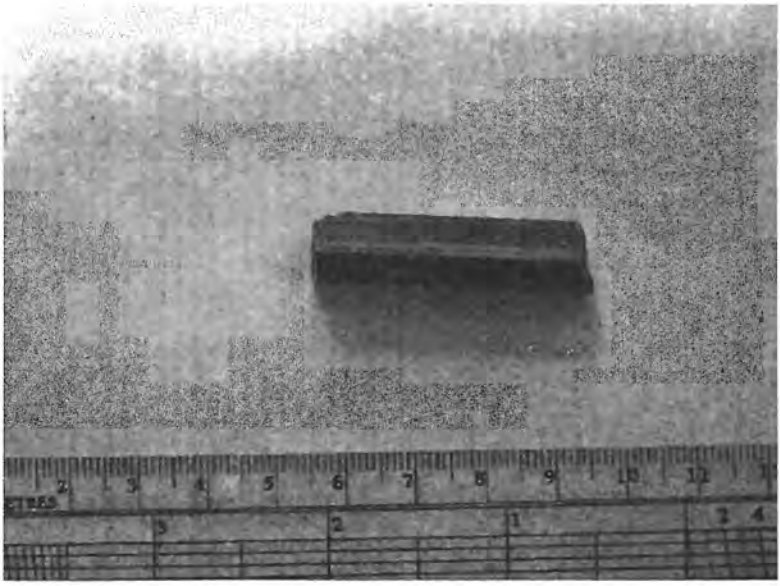

Plate 7. Black color tourmaline (Schorl) from the pegmatites of Hashupa area in Shigar valley. The size of crystal is ≅ 4cm x 1cm. Numerous striations can be seen along the hexagonal prismatic faces.

Topaz [$Al_2SiO_4(F, OH)_2$]

Colourless topaz is reported from Yuno, Kashmol, Dassu, Nyit Bruk, and Goyungo. The topaz crystals vary in size; however, the biggest topaz obtained during this study is from Kashmol area, which is about 1 cm to 2cm across (Plate 8). The topaz crystals generally have tetragonal prisms and c-pinacoid. The topaz crystals are usually present within the microcline-quartz- muscovite matrix.

Quartz (SiO_2)

Large, transparent crystals of quartz up to 40 cm long and 12 cm wide are reported from the pegmatites of various localities along the Braldu River. These can be used as rock specimens and decorative stones. The lumps of quartz crystals of various sizes collected from the pegmatites of the Shigar valley are shown in (Plate 9).

In addition to the above- mentioned gemstones, certain other gemstones have also been found from various localities of the Shigar valley, including the lower reaches of the Braldu river. These include: yellow apatite, epidote and its different varieties, diopside and sphene (titanite) from Alchuri, Hashupa, Hurchus; apatite from Dassu, Mungo, and Nyit Bruk etc.

Plate 8. Transparent crystal of topaz from pegmatite body in Kashmol area. The size of crystal is about 1cm to 2cm across. Tetragonal prisms along with c-pinacoid are also present.

Plate 9. Lump of quartz crystals of various sizes collected from Shigar valley pegmatites.

REFERENCES

Desio, A., 1963. Review of the geological formations of the western Karakoram (Central Asia). Rivista Italiana de Paleontologia e Stratigraphia. 69, 475- 501.

Desio, A., 1979. Geological evolution of the Karakoram. In: Geodynamics of Pakistan (A. Farah & K.A. De Jong, eds.), Geol. Surv. Pakistan, 111 – 124.

Desio, A., Tongiorgi, E. & Ferrara, G., 1964. On the geological age of some granites of the Karakorum, Hindu Kush, and Badakhshan, Central Asia, 22nd Intern. Geol. Congr., New Delhi, 11, 479-496.

Frase, J.E., Searle, M.P., Parrish, R.R. & Noble, S.R., 2001. Chronology of deformation, metamorphism and magmatism in the Sothern Karakoram Mountains. Geol. Soc. Am. Bull., 113 (11), 1443-1455.

Gubelin, E., 1981. Pakistan enters the gem scene. Gems. Gemol., 17, 180-181.

Hanson, C. R. 1989. The northern suture in the Shigar valley, Baltistan, Northern Pakistan. In: Tectonics of the Western Himalaya (L.L. Maliconico & R. J. Lillie. eds.), Geol. Soc. Am. Spec. Paper, 232, 202- 216.

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

Kazmi, A.H. & O' Donoghue, M. 1990. Gemstones of Pakistan. Gemstone Corp. Pakistan. 146p.

Laurs, M B., Dilles, J.H., & Snee, L.W. 1986. Emerald mineralization and metasomatism of amphibolite, Khaltaro granitic pegmatite- hydrothermal vein system, Haramosh Mountains, Northern Pakistan. Canad. Mineral., 34, 1253-1286.

Laurs, M. B., Dillas, J.H., Wairrach, Y. & Kausar, A.B., 1998. Geological setting and petrogenesis of symmetrically zoned, miarolitic granitic pegmatites at Stak Nala.

Nanga Parbat-Haramosh massif, Northern Pakistan. Canad. Mineral., 36, 1-47.

Middlemiss, C.S. & Parshad, L.J., 1918. Note on the aquamarine mines of Dassu on the Braldu River, Shigar valley, Baltistan. Rec. Geol. Surv. India. 45, 160 – 172.

Searle, M. P., 1991. Geology and Tectonics of the Karakoram Mountains, John Willy & Sons, New York.

Searle, M. P. & Tirrul, R., 1991. Structural and thermal evolution of the Karakoram crust, Jour. Geol. Soc. London, 148, 65 – 82.

Searle, M.P., Rex, A. J., Tirrul, R., Windley, B.F., St. Onge, M. & Hoffman, D., 1986. A geological profile across the Baltoro Karakoram Range, N- Pakistan, Geol. Bull.Univ. Peshawar, 19, 1-12.

Searle, M.P., Rex, A. J., Tirrul, R., Rex, D.C, Barnicoat, A. &. Windley, B.F.,. 1989. Metamorphic, magmatic, and tectonic evolution of the Central Karakorum in the Biafo- Baltoro- Hushe regions of N. Pakistan, Geol. Soc. Am., Spec. Paper, 232,47-73.

Tahirkheli, R.A.K., 1982. Geology of the Himalaya, Karakorum and Hindukush in Pakistan, Geol. Bull.Univ. Peshawar, 15, 51p.