

Pakistan.... With enormous gem potential

Pakistan - better known as a producer of some fine quality of emeralds up till few years back, but now in the recent past the gem and mineral world trade have witnessed some extremely fine quality of other gemstones from the region. Some of the minerals make the country / region prominent in the mineral world.

Pakistan is bounded by Afghanistan in the northwest, while India in the east and Iran in the west. The northern and northwestern part of Pakistan produces the maximum number of gemstones. Three world famous ranges Hindkush, Himalayas and Karakoram, enclose the gem producing region.

Some of the well-known gem species supplied to the world market from the region includes aquamarine, topaz, Peridot, ruby, emerald, amethyst, morganite, Zoisite, spinel, sphene, tourmaline, spessartite and demantoid.

Pakistan has produced and still producing some extremely fine quality of peridots, spessartite garnets, orange topaz, chrome diopsides and now recently demantoids.

Looking at the mineral potential, the mining techniques and policies followed by the government is not up to the mark. Most of the stones are mined by the locals / tribal people by unconventional techniques thereby, compromising in quality and quantity.

Recently, at GTL, we analysed few samples of Milky Chalcedony, Vesuvianite and a rarer gem species- Phenakite from Pakistan. Three samples of Phenakite were observed, which were colourless, refractive index varied between 1.652-1.671 with birefringence of around 0.018, clear Uniaxial optic figure was resolved with positive sign, specific gravity measured at 2.95, all the three samples were eye clean but at higher magnification, individual fingerprints were observed with 2-phase inclusions.

Demantoid Garnet- Rediscovered!!

Demantoid, one of the most rare varieties of Garnet group has been re-discovered in the Urals in Russia and is now encountered in the market much frequently than ever before.

Demantoid, the term is derived from the Dutch word *demant*, meaning diamond. Demantoid was first discovered in the mid to late 1800s in Russia during the reign of Czar Alexander II. The newly discovered gemstone made an impressive showing, enhancing the cultural life of Russian nobles. Demantoids were used by Karl Faberge' in combination with enamel and gold in his jewel creations for royal treasures.

Demantoid belongs to the *andradite* species a calcium iron silicate; $\text{Ca}_3\text{Fe}_2(\text{SiO}_4)_3$. The stones range in colour from pale green to yellowish green to emerald green. The colour of Demantoid equivalent to fine emerald is very rare an emerald green is ideal for Demantoids. If the same stone have a strong yellow as primary component and lesser green, it will be termed as 'Topazolite' the yellow coloured variety of Andradite. The colour of Demantoid should be as intense as possible, without possessing black overtone or yellow secondary shade.

Demantoid has derived its term from diamond because of its high brilliance and adamantine lustre. The brilliance and lustre- both depends on the refractive index. As the refractive index increases, the lustre and brilliance increases. The RI of Demantoid varies between 1.880 and 1.888- one of the highest values reported for natural coloured gem materials.

Another feature of Demantoid is the high dispersion of 0.057, while other garnets have low to moderate of 0.022 to 0.028. The dispersion value of Demantoid is even higher than that of diamond, which measures at 0.044. This high dispersion of both Demantoid and Diamond make them an effective simulant for each other.

Some basic properties of Demantoid are as follows:

Crystal System : Cubic; crystals vary from well formed to water worn pebbles. Crystals often are do-decahedron in shapes.

Optic character : Isotropic (SR)

Refractive Index : 1.880 1.888 (SR)

Dispersion : 0.057

Lustre : adamantine

Hardness : 6.5 to 7

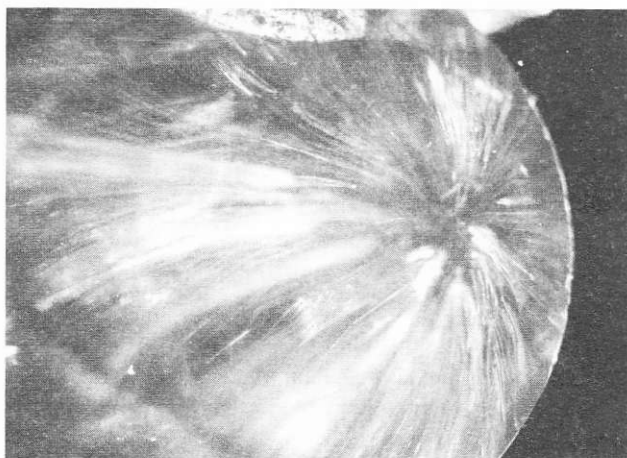
Specific Gravity : 3.84

Spectrum : strong band at 443nm, weaker bands at 622 and 640, doublet at 693.

The colour of Demantoid is due to the presence of trace elements - iron and chromium. Iron is present in its ferric as well as ferrous states giving variations in body colour from yellow to green. The presence of chromium produces emerald green.

Recently, we got a chance to analyze few Demantoids from Russia courtesy Mr. Mehul Durlabhji, Co-convenor, GTL, who kindly donated the samples to us for study. The samples ranged in size from 0.10 carat to 0.43 carat, and the colour ranged from light green to dark green with the secondary yellow colour. The optical and physical properties were consistent with those described for Demantoid. Almost all the samples had characteristic 'horse-tail' inclusion- the stamp of Demantoids.

These are basically, byssolite (fibrous form of amphibole) and/ or chrysotile (fibrous form of serpentine), forming a comet-like pattern. These appear as fine strands connected at one end by a common centre; sometimes this centre could have a crystal of Chromite.



The original locality of Demantoid was in Ural Mountains in Russia. It is found in alluvial deposits of the Sissersk District, Nizhni-Tagil and from Bobrovka River.

The Bobrovka River in the Ural Mountain region has historically been considered as the premiere source of Demantoids. Currently, extremely fine Demantoid being brought out is limited, with commercial material more easily available. Ural Demantoids are generally smaller in size than those found at other newer sources including Namibia, Italy, Iran, and Pakistan. Compared to the Russian Demantoids, Namibian stones have more blackish overtone that makes the stone less expensive.

Demantoid can be confused with other member of the same group Tsavorite, which can be differentiated by its lower lustre and dispersion, lower RI and different spectrum. Other materials, which imitate Demantoid, are Glass, Yttrium Aluminium Garnet (YAG), Natural Zircon, Synthetic Cubic Zirconia, Green Diamond, Tourmaline, etc.

The most characteristic feature for Demantoid is its lustre and brilliance along with the inclusions and spectrum. Glass has got a lower lustre and presence of gas bubbles, YAG can be differentiated on the basis of higher SG of 4.60, and Natural Zircon is identified on the basis of strong doubling and characteristic spectrum at 653.5nm.

Synthetic Cubic Zirconia can be differentiated by higher heft, having SG of 5.40 to 6.20 and high dispersion. Green Diamond is identified on the basis of its lower SG of 3.52 and inclusions, while tourmaline by its lower SG, lustre, anisotropic nature and strong pleochroism.

Demantoid's fire / brilliance is best seen in lighter, less saturated gems. Thus, the colour preference varies from individual to individual; some prefer an intense body colour and less fire, while others prefer a lighter body colour and more fire. It should be noted that that Demantoids look best under daylight. Incandescent light makes the stone more yellowish; also diffused lighting should be avoided while observing the brilliance of the stone.

Mining areas.... The few potential / major gemstone mining areas in Pakistan are:

Northwest Frontier Province

- Swat (Malakand division) : Emerald, Quartz and Epidote
- Dir (Malakand division) : Corundum and Quartz
- Mansehra (Hazara division) : Corundum and Quartz
- Kohistan (Hazara division) : Peridot, Demantoid
- Peshawar district (Frontier province) : Quartz, Xenotime and Bastnaesite

Federally Administered Tribal Areas

- Mohmand Agency : Emerald, Clinozoisite, Spheue and Epidote
- Bajaur Agency : Emerald, Garnet, and Scapolite
- Khyber Agency : Quartz, Xenotime and Bastnaesite
- North and South Waziristan Agencies : Quartz

Northern Areas

- Chilas (Diamer district): Diopside, Zircon, Quartz, Aquamarine, and Tourmaline
- Gilgi, Hunza and Shigar (Gilgit district): Beryl, Topaz, Emerald, Quartz, Apatite, Spinel, and Pargasite
- Shengus, Stak Nala and Tormiq Nala (Baltistan district): Beryl, Topaz, Tourmaline, Apatite, Spheue, and Quartz
- Childee, Kashmal and Yuno (Shigar area, Baltistan district) : Beryl, Tourmaline, Apatite, Topaz, and Quartz
- Hyderabad, Testun, Dassu, Net Tahirabad and Goyungo (Shigar area, Baltistan district): Topaz (best quality), Beryl, Emerald, Apatite, and Tourmaline
- Appu Aligund, Fuljo, Braldu, and Karma (Baltistan district): Beryl, Emerald, Tourmaline, Diopside, Ruby, Topaz, Scheelite, Quartz and Pargasite.

Baluchistan Province

- Kharan district: Brookite, Anatase and Quartz
- Chaman (near Quetta): Quartz

The gemstone and mineral wealth is basically concentrated in the northern part of Pakistan, which is quite difficult to access and explore due to the extreme conditions, but on the basis of this wealth only, it can become a great hub of the gemstone industry, very similar to Brazil, provided if it takes few essential and effective steps towards the exploration of this wealth.

GTLiars' corner...

Dr. Treat (er) and his Summer Holidays... with. ...Ruby

1st summer - Dr. Treater in India

Dr. Treat: Ms. Ruby, how are you? What has happened to you, so dull, highly cracked!

Ruby: Yes, doc. it's my nature, I am born like this!

Dr. Treat: Come, I will treat you. I will dye you so that those cracks will not be seen.

Ruby: Thanks doc.

Next day, Ruby gets treated with coloured oil / dye and then unfortunately lives a life of tragedy with those 'colour patches along the cracks'.

2nd summer Dr. Treat in Sri Lanka

Dr. Treat: Ms. Ruby, Why you are so unevenly coloured, why there are colour patches in you? Have you been treated?

Ruby: No doc., I have not been treated! This is my nature I am born like this!

Dr. Treat: C'mon I will treat you and remove all those patches by giving you a high temperature heat!

Ruby: No thanks doc. I don't want to be treated; I am okay as I am.

But...

Next day, she gets treated under high temperature and...she cries with pain- giving 'melted crystals' and shouts at the doctor by creating 'burst halos'.

3rd summer Dr. Treat in Burma

Dr. Treat: Ms. Ruby, you remember I treated your Sri Lankan counterpart at high temperature, but I could not hide the large fractures!

Ruby: Yes, doc, but why you are saying this to me? What do you want from me?

Dr. Treat: Oh! Nothing, I just want to hide your fractures with some glassy material and then you will appear much better.

Ruby: Oh! No doc, I just want to be as I am.

But....

Next day, she gets filled with silica glass based materials borax/ glass and carrying 'alien substances' in her womb.

4th summer Dr. Treat in Madagascar

Dr. Treat: Ms. Ruby, remember, when I treated your Burmese counterpart, I could not hide all the fractures completely, therefore I have a new material for you- a much better one!

Ruby: No doc! Let me live as I am. Let the world accept me in my natural state...

But....

Next day, she gets filled with lead based glass giving thick sugary and reflecting patches of foreign body.

And at the end of the day... it is only ruby and the trade who suffers!

And there is a continuous love and hate relationship between treaters and gemologists. One tries to justify self by improving the quality of the gems, while the other tries to prove him wrong by identifying the treatment.

By : D. Mohit Challani, MDGI- Batch No. 9

What's running these days: - Trend...Orange...

At the recent Hong Kong jewellery show a number of booths had displayed their jewellery with orange coloured gemstones in various transparencies and shades. Few stones that were being used and / or found in those specific colour shade include Spessartite garnet, Sapphire, Topaz, Zircon, Chalcedony (Carnelian), Fire Opal, Amber, and Glass. These are only the few common ones, there are much more...

Now, since orange colour of sapphire is also and more commonly obtained by beryllium diffusion, the identification becomes more difficult. The beryllium treatment in sapphires can be identified by the presence of colour rim, but that is visible only in 2-3% stones. Sophisticated techniques like Laser Induced Breakdown Spectroscopy (LIBS) and Laser Ablation-Inductively Coupled Plasma- Mass Spectroscopy (LA-ICP-MS) can identify the treatment conclusively but these are expensive and the cost of testing can be higher than the cost of the stone.

Out of the listed stones few acts, as a simulant for each other therefore individual identification is necessary, which may be done using their RI, SG, inclusions, etc. Spessartite garnet can be identified by its characteristic colour, spectrum and inclusions, while sapphire by its RI at 1.76-1.77 and its typical inclusions of silk, fingerprints, halos, etc. Topaz can be identified on the basis of its RI and SG of 3.54, Zircon by its dispersion, doubling and spectrum, chalcedony by lower left and banding pattern, Fire opal by its very low left, SG of 2.20, cloudy nature and possibly play of colour. Amber is identified by its resinous lustre and flora / fauna inclusions, salt-water test, while Glass by swirls marks, gas bubbles, devitrification and SR nature. The properties of the commonly available materials are given in the following table.

Stone	Optic Character	RI	SG	Inclusions / Other Featurest
Spessartite Garnet	SR / ADR (SR)	1.790- 1.810 SR	4.12 - 4.20	Liquid fingerprints with shredded appearance, fibres, crystals. Spectrum: Bands at 412, 424, 432nm
Chalcedony	DR, AGG due to structure	1.54 Weak blink	2.58-2.62	Banding, aggregation in Immersion
Sapphire	DR, Uniaxial negative	1.760 - 1.770 0.008	4.00	Liquid fingerprints, crystals, zircon halos, silk, etc.
Fire Opal	ADR/SR AGG due to structure	1.45 - 1.47 No blink	1.98 - 2.20	Cloudy inclusions, dendritic patterns
Topaz	DR, Biaxial positive	1.609 - 1.638 0.008	3.51 - 3.56	Cleavage cracks, non-miscible liquids, phase, fingerprints.
Zircon	DR, Uniaxial positive	1.925 - 1.984 Over-range 0.059	4.67 - 4.70	Doubling, zoning, crystals, etc Spectrum: strong line at 653.5 with other lines across the spectrum.
Amber	SR / ADR (SR)	1.54	1.05 - 1.08	Flora / Fauna inclusions, crazing, flow lines, gas bubbles. Floats in salt water
Glass	SR AGG due to inclusions	1.45 - 1.60 SR	2.40 - 2.80	Gas Bubbles, Coloured Swirls, Hemispherical pits, Devitrification effect.

Created and Edited by : **Gagan Choudhary**, Asst. Director (Tech. & Training)
 Contact for further details : **Mustaqeem Khan**, Asst. Director (Tech. & Training)
Meenu Brijesh Vyas, Asst. Director (Tech. & Training)
Radhamani Amma, Asst. (Coordination & Info.)

Rajasthan Chamber Bhawan
 M. I. Road, Jaipur, India
 Phone : 91-141-2568221,2573565
 email: gtljpr_jp1@sancharnet.in