WORLD EMERALD UPDATE

The Emerald Mines of the Panjshir Valley, Afghanistan

By Gary Bowersox

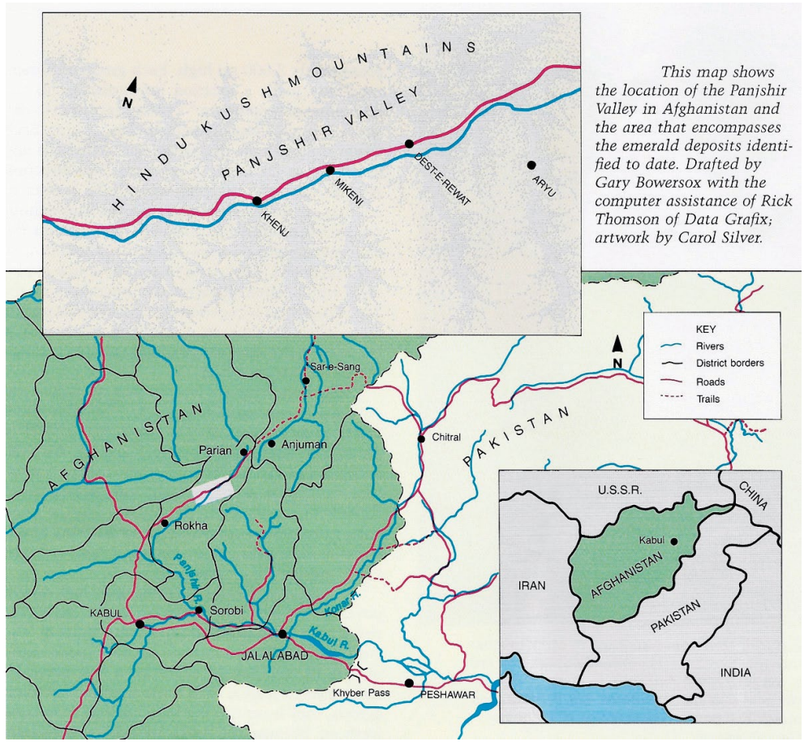
In the first century A.D., Pliny, writing in the *Natural History* referred to the occurrence of "smaragdus", a Latin term referring to emerald and other green stones in the vicinity of Bactria, the geographic area including present day Afghanistan. In fact, the presence of "emeralds" has reportedly come from this region for thousands of years. Afghanistan's Panjshir Valley, an hour drive north of the capital city Kabul, now has commercial emerald production. Such known production only commenced in the early 1980s and has primarily been conducted by Afghan enterprises and individuals much of which is based on historic customary, tribal and family-based operations.

Large, dark green crystals have been discovered by local Afghans in hundreds of tunnels and shafts throughout the Valley. Informal removal and sale of these emeralds served to financially support the activities of the Mujahideen ('freedom fighters') during the Soviet occupation of Afghanistan (1979-89). Since that time the emeralds mined have continued to provide an informal, if not lucrative, business opportunity for local Afghans. Emerald mining in Afghanistan has never been formalized; no legal licensing of emerald mines is known to be in place. Nonetheless, emerald production conducted by local Afghans generates an estimated $10 million each year; revenues generated are not formally taxed.

Fig. 2: The Panjshir Valley in Afghanistan from the south looking north towards the emerald mining area. (Photo by Gary W. Bowersox)

Fig. 2A: An emerald crystal in host rock from a mine near Khenj village, Afghanistan. (Photo by Kay Kolt-Bowersox)

Fig. 3: Photo of a 9,000 carat lot of Panjshir Valley emeralds. (Photo by Gary W. Bowersox)



This map shows the location of the Panjshir Valley in Afghanistan and the area that encompasses the emerald deposits identified to date. Drafted by Gary Bowersox with the computer assistance of Rick Thomson of Data Grafix; artwork by Carol Silver.

Fig 1: The Darun emerald mining area is located in the back of the mountain range shown in this photo taken from the Panjshir Valley road. The Darun emerald mines are the farthermost north of all known emerald mines in Panjshir Valley.

The emerald mines of Afghanistan are located approximately 70 miles (113 km) northeast of Kabul and extend from the village of Khenj to Dest-e-Rewat. The known elevations of the emerald deposits range from 7,000-14,300 feet (2,135-4,270 meters) amidst mountainous terrain on the eastern side of the Panjshir River. The estimated area of emerald deposits is approximately 150 sq. miles (400 km2).

A survey of emerald deposits and mines was conducted by this author in 2009 along with geologically-trained team members Derrold W. Holcomb and Dr. Lawrence W. Snee. The main purpose of the ground survey was to provide data and the approval of the emerald miners to be licensed by the government. The miners allowed the taking of GPS readings at their mine sites and approved of having legal government licenses issued.

The survey confirmed indications that the actual emerald bearing area extended beyond local miners' operations to include an additional area equal to 30 percent of the known area. However, an issue in conducting the survey was that some miners were not able, or were unwilling, to fully understand the purpose of such survey work, the GPS process, or any of their potential benefits. Based on

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Fig. 4: A new house being constructed near an emerald mine shaft using host rock from the mine. Outside the home is a toilet which is a new concept in this mining area. (Photo by Shahiq Habibi)

Fig. 5: A distant view of the Khenj mining area showing new homes on terraced land. (Photo by Shahiq Habibi)

Fig. 6: A small camp of poor miners exploring for emeralds high in the Hindu Kush Mountain Range. (Photo by Derrold Holcomb)

this author's decades of experience in Afghanistan, this reaction was attributed to the high rate of poverty and illiteracy of those miners who simply preferred to be left to mine their area, under what they considered to be their rightful customary, tribal or family property.

Following completion of the ground survey, the data was transferred onto satellite image-maps (Fig. 14 Satellite Map). The team interviewed approximately 1,400 miners working at 172 emerald mines and was shown transparent to translucent emerald crystals ranging from 4 to 5 carats with some crystals exceeding 100 carats. Color zoning was observed to be common and the exteriors or skin of the crystals were, in many cases, darker than the interiors. (Fig. 13: 36-carat Panjshir emerald crystal and Fig. 12: a carved 70.45-carat Panjshir emerald).

The Panjshir Valley is a major fault zone between two crustal plates, the ancestral Eurasian plate to the northwest and the micro-continental fragment known as Cimmeria to the south-east. The closure of the plates in Panjshir marks the location of a major ocean basin known as the Paleo Tethys. It is speculated that the emeralds were formed from beryllium-rich hydrothermal fluids that rose from depth upwards along

Fig. 8 (left): Miners entering a mine shaft. (Photo by Shahiq Habibi)
Fig. 9 (middle): Afghanistan emerald miners use lanterns for light and heat. (Photo Shahiq Habibi)
Fig. 10 (right): Miners viewing emerald bearing rocks. (Photo by Shahiq Habibi)

Fig. 11: Emerald mine survey team in the Panjshir valley with three U.S. citizens and eight Afghans discussing their next climb up the mountain. The project was sponsored by USAID. (Photo by Gary W. Bowersox)

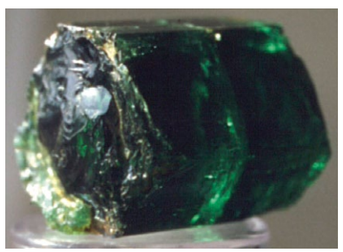

Fig 12 (left): A 70.45-carat Panjshir emerald carved by Uli Pauly in the likeness of Alexander the Great's horse 'Bucephalus' ridden by Alexander when he conquered territory from Greece to India including Afghanistan. (Photo by Gary W. Bowersox)

Fig 13 (right): A 36-carat emerald crystal showing nodule and skin. (Photo by Gary W. Bowersox)

this deep-seated fault zone about 16 million years ago. These fluids reacted with chromium-rich rich rocks resulting in the substitution of a few thousand ppm Cr for Al in the beryl crystal structure. (Fig. 17 – Aerial view of the Panjshir Valley showing the fault line and river).

Teams of Afghan miners use dynamite and drills to remove the black shale hosting the emerald-bearing quartz and ankerite veins. The miners follow the yellow hydrothermal alteration zones and veins in search of emeralds. Upon discovery, they excavate the contact zone between carbonate and clastic host rock formations using dynamite, to the detriment of the crystals and overall resource.

The gemological properties of Panjshir emeralds are consistent with those of emeralds from other global locations; chemically, they are most similar to emeralds from the Muzo mine in Colombia (Fig. 19 – chemical analysis of four Panjshir emeralds).

Emerald-bearing rocks throughout the Panjshir Valley are pervasively cut by hydrothermal veins. These veins contain iron carbonate, albite, silica, iron oxides, beryl, mica (phlogopite or fuchsite), tourmaline and salts such as halite, sylvite and fluorite. Where these veins are located close to chromium rich rocks, the beryl occurs as emerald.

Over the last three years, mining methods used to exploit emeralds in the Panjshir Valley have changed and even improved from shafts and tunnels, to trenching, and open pits with reduced use of explosives and blasting, improved water control, and the addition of mine-site bathrooms for sanitary purposes. Unlike other mining jurisdictions, children are not engaged in Afghan emerald mining.

Not only are the emerald miners of the Panjshir Valley working in an active war zone, they are operating mines

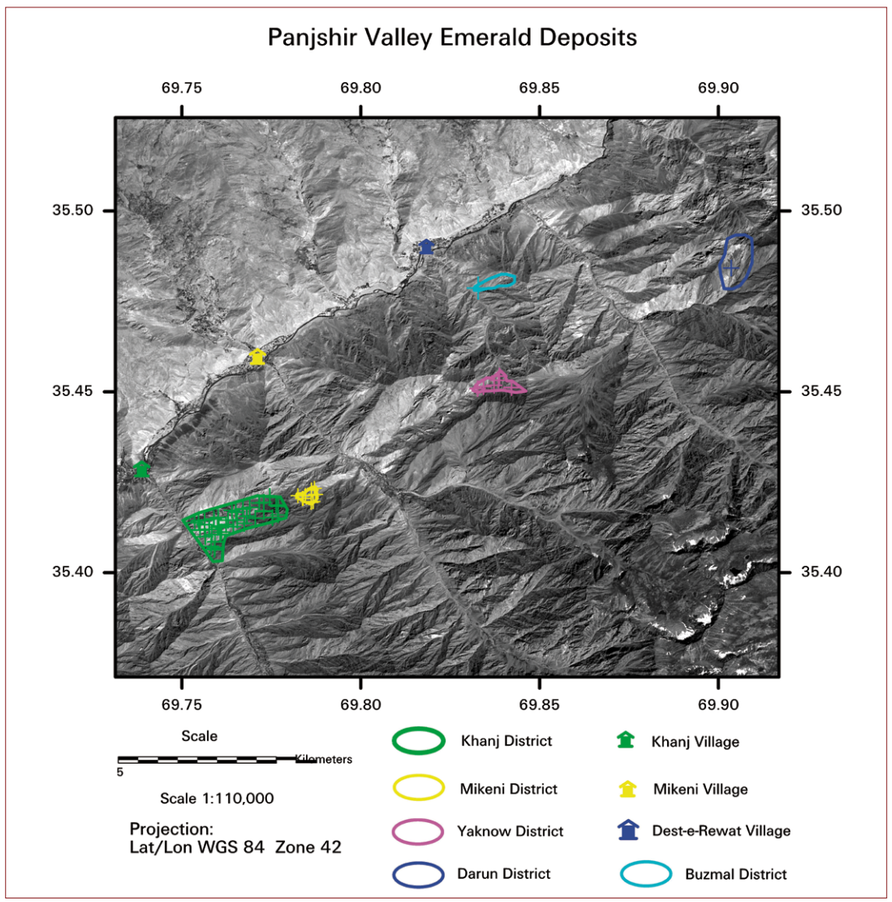

Fig 14: Panjshir valley emerald mine deposit locations and village coordinates recorded by the survey team using GPS and printed on a satellite map of the Panjshir Valley, Afghanistan. (Prepared by Derrold W. Holcomb)

Fig.15 (left): Heavy equipment is now being used in the emerald mining operations. (Photo by Shahiq Habibi)
Fig. 16 (middle): A compressed air drill being used by a miner to make a blasting hole in the host rock. (Photo by Shahiq Habibi)
Fig. 17 (right): An aerial view of the Panjshir Valley, Afghanistan, showing the fault line and the Panjshir River known as the 'Five Lions River.' (Photo by Gary W. Bowersox)

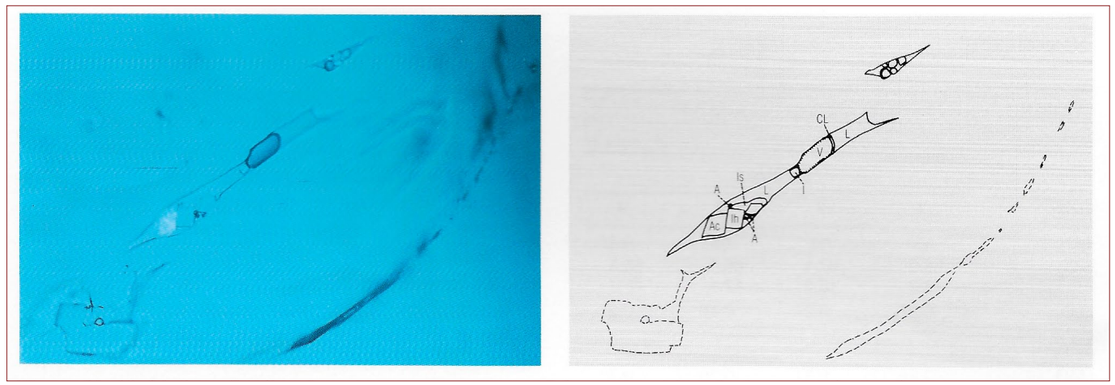

Fig. 18: Multiphase fluid inclusions are common in Afghanistan emeralds. The larger inclusion shown here contains four isotropic and four anisotropic daughter minerals, brine (L) CO_2 - liquid (CL) and vapor (V). The inclined cubic habit of the largest isotropic phase is suggestive of halite (Ih). The lower refractive index isotropic mineral may be sylvite (Is). The identity of the other isotropic daughters (I) is unknown. The large rhombic is probably a carbonate (Ac). The identity of the three smaller anisotropic minerals (A) is unknown. The CO_2 liquid forms a barely visible crescent between the vapor bubble and brine. The smaller inclusion contains two isotropic and two anisotropic daughter minerals in addition to brine and vapor. The length of the large inclusion is 200 µm. (Photomicrography by Robert R. Seal II; magnified 200x)

without legal status. The 2014-installed government of Afghanistan claims the rights to all land and production rights in mining areas but, to date, has failed to establish a viable legal and regulatory framework that may be practically implemented for emerald mining.

The international donor community initiated assistance efforts in the Afghan minerals market as early as 2003. Since 2007, several donors have provided funds specific to gemstone and even emerald mining including GIZ for gemstone quality, USAID for small business development, and DfID for formalization of artisanal mining. Despite significant funding, World Bank assistance has not focused on artisanal or small-scale mining – the type of mining typically conducted by Afghans. The expanse of international assistance has included legal drafting, technical assessment, training and even financial support and guidance for road shows, public relations and international marketing.

For reasons ranging from short-term program objectives, the inability of donors to work far beyond Kabul and changes in Afghan government priorities, many of these efforts have failed to "stick". This author has participated in assistance specific to emeralds including: training in gemology, geology, marketing and sales trips and GPS survey coordinates to define and secure emerald mining licenses. And, despite donor assistance, formalized emerald operations for Afghan miners remain elusive which inhibits security of tenure, certainty of operations, financial leverage, valuations and production quality.

To assist with the entire mineral industry, a World Bank funded program was completed at great expense to provide computerized hyperspectral data to the Afghanistan government. In the case of emerald deposits, this program may be expected to provide valuable information toward determining the extent of the critical hydrothermal zones where emeralds exist in the Panjshir Valley. Despite the accumulation of extensive geo-science and other such data, the government has ignored using such available data to advance the industry. In fact, the server established to house the national data by the US Geological Survey has been closed.

The legal regulatory drafting by world-renown lawyer Mary Louise Vitelli was based not only on good international practices but was relevant to Afghan mining. However, it has been virtually redrafted to suit other interests. One significant result of the government's inconsistent application of valuable work product is that Afghan emerald miners are left to operate without a viable market framework, thereby regarded as "smugglers" with emeralds leaving the country without requisite governmental approvals. Still, the government does not have a system or program in place by which to register emerald miners or provide a legal license.

Where there is some legal and regulatory guidance it is impractical for Afghan emerald miners – i.e., current government regulations require duties, royalties and taxes that total more than 50% of the value of the exploited emeralds. Outside the legal and regulatory framework, ample evidence exists of government employees demanding that emerald miners and traders pay 'baksheesh' or a bribe to obtain any required paper work including permission to export.

Fig 19: Chemical analyses of four Panjshir emeralds resulted in the following data.

Oxide	Analysis 1	2	3	4
TiO_2	na[b]	na	na	0.21
SiO_2	66.0	67.1	65.1	65.5
Al_2O_3	18.2	18.2	17.1	16.4
FeO_T (Total iron as FeO)	0.27	0.27	0.46	0.61
MgO	0.22	0.31	0.75	0.70
CaO	na	na	na	0.07
Na_2O	0.21	0.30	0.70	0.99
V_2O_3	0.08	0.07	0.03	0.10
Cr_2O_3	0.19	0.23	0.10	0.54
BeO[c]	13.8	14.0	13.5	12.04
Total	98.9	100.5	97.7	97.16
Weight loss[d]	na	2.2 %	na	na

[a]Analyses 1, 2, and 3 are microprobe data from Hammarstrom (1989). Analysis 4 is an average of instrumental neutron activation analysis and induction—coupled argon plasma—atomic emission spectrometry data from Snee et al. (1989).
[b]na = not analyzed for.
[c]Theoretical amount of BeO computed for analyses 1, 2, and 3 assuming 3.00 Be cations per formula unit; since Al and Si can substitute in the Be site in the beryl structure, this assumption may not be valid. BeO for analysis 4 was directly determined.
[d]Weight loss was determined by heating one half of the emerald crystal from room temperature to 1400°C in a thermogravimetric analyzer and measuring the weight difference; the other half of the crystal was used for the microprobe analysis.

Credit: Gems & Gemology article 'Emeralds of the Panjshir Valley,' Afghanistan by Gary Bowersox, Lawrence W. Snee, Eugene E. Foord, and Robert R. Seal. Gem & Gemology, Spring 1991 p.36

Conclusions

Afghan emerald miners are improving their operations; viable if rather crude emerald mining continues in the Panjshir Valley of Afghanistan. Local miners are not yet under the threat of the Taliban, Al Qaeda, ISIS or even the Afghanistan government. In spite of this tenuous environment, miners operate at a profit, employing local villagers and promoting an improved standard of living. This locally based work accomplishes more on a practical basis for the local Afghan than any donor or government assistance has.

While the Afghanistan government/international donors are not receiving appropriate tax, royalty and other industry payments from the Panjshir Valley's emerald production, emerald miners are forced to operate outside the benefits of government/donor training and Afghanistan's citizens do not gain the emerging protections for environmental and social entitlements. Following years of illicit operations and war-funding, it is the hope of this author that both emerald miners and government, in tandem with donors, will soon identify practical measures to progress this viable mining sector in Afghanistan to develop an equitable, co-operative relationship to the benefit of all of Afghanistan's citizens.♦

Fig 20: Heavy equipment is being used to rapidly remove overburden at the mine site. It will be interesting to see what emeralds are discovered as the open pits are deepened. (Photo by Shahiq Habibi)

Notes:

1. kilometers
2. Square kilometers
3. The survey team was funded through the ASMED-USAID program and GPS (Global Positioning System) to record readings at each mine with the specific purpose of licensing existing operations and for mapping purposes.
4. By team member Derrold Holcomb.

About the Author:
Gary W. Bowersox, President of Geovision, Inc. is a gemologist and has been exploring Afghanistan for more than 44 years; his books include reviews of Afghanistan's geological context and mineral wealth. In addition to conducting shows around the world, Mr. Bowersox works as an independent consultant throughout Afghanistan and Pakistan.

References:

- Abdullah, S., V.M. Chmyriov V.M, Stazhilo-Aleseev K.F.,Dronov V.I., Gannon P.J., Lubemov B.K., Kafarskiy A. Kg., Malyarov E.P., (1977) *Mineral Resources of Afghanistan*, 2nd ed. Afghanistan Geological Survey, United Nations Development Program. Program Support Project AFG/74/012, Kabul.
- Bowersox, Gary W. 1985 *A Status report on gemstones from Afghanistan.* Gem & Gemology Vol. 21, No. 4, pp. 192-204.
- Gary Bowersox, Lawrence W. Snee, Euguene E. Foord and Robert R. Seal II. 1991. Emeralds of the Panjshir, Afghanistan. Gems & Gemology, v. 27, no. 1, pp. 26-39.
- Bowersox, Gary W., B. Chamberlin, 1995 *Gemstones of Afghanistan*, Geoscience Press, Inc. Tucson, AZ. Pp. 220.
- Bowersox, Gary W. 2004, *The Gem Hunter – True Adventurers of an American in Afghanistan*. Geovision, Inc. pp.505.
- Chmyriov V.M., Kafarskyiy A.Kh, Adullah D., Dronov V.I. Stazhilo-Alekseev K.F. 1982 *Tectonic Zoning of Afghanistan*, Vol. 41, Part 3.
- DeBon F. Afzali H., LeFort P., Sonet J., Zimmermann J.L. 1987. Plutinic Rocks and Associations in Afghanistan: Typology, Age and Geodynamic Setting. Science de la Terre, Memoir 49, Nancy France.
- Hammarstrom J.M. 1989 Mineral Chemistry of emeralds and some associated minerals from Pakistan and Afghanistan: electron microprobe study. In A.H. Kazmi and L.W. Snee. *Emeralds of Pakistan- Geology, Gemology and Genesis*. Van Nostrand Reinhold, New York, pp. 125-150.
- Neilson, J. B., and P.J. Gannon. 1977. Mineral Evaluation Project Afghanistan: Volume 2, Significant Mineral Occurrences. United Nations Development Program, AFG/74.002, Toronto.
- Seal, R.R. II 1989. A reconnaissance study of the fluid inclusions geochemistry of the emerald deposits of Pakistan and Afghanistan. In A. H. Kazmi and L. W. Snee (eds.) *Emeralds of Pakistan-Geology, Gemology and Genesis*, New York. Van Nostrand Reinhold, pp. 125-150.
- Snee, L.W., E.E. Foord, B. Hill and S.J. Carter. 1989. Regional chemical differences among emeralds and host rock of Pakistan and Afghanistan: Implication for the origin of emerald. In A. H. Kazmi and L. W. Snee, (eds.) *Emeralds of Pakistan – Geology, Gemology and Genesis*. New York: Van Reinhold, pp. 125-150.