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Geology and Field Studies of Reported Andesine Occurrences In the Shigatse Region of Tibet

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Abstract

In late September 2010, an international group traveled to the Shigatse region of Tibet and visited two reported andesine occurrences located near the previously investigated Nai Sa–Bainang mining area, at Zha Lin village and the Yu Lin Gu alluvial fan. Andesine in this area is associated with alluvial deposits derived from marine sedimentary rocks that are cross-cut by quartz veins. The recovery of andesine from random pits dug in undisturbed locations around the former mining area at Zha Lin provided strong field evidence for a genuine andesine deposit. The group could not confirm the authenticity of the Yu Lin Gu occurrence because andesine was only found at or very near the surface of an active alluvial fan. The team found no outcrops (or clasts) of the type of rocks expected to form gem-quality andesine in either area, and a more thorough geologic investigation of the region is still needed.

INTRODUCTION

The existence of natural gem-quality andesine from Tibet or China has been the subject of controversy since 2006 (see figure 1 and Rossman, 2011). Author AA visited one of the reported andesine deposits, at Nai Sa–Bainang (or Bai Lang), in 2008 (Abduriyim, 2008, 2009a, 2009b). In mid-2010, researchers from the National Gemstone Testing Center Laboratory in Beijing did brief field studies of the area (Wang et al., 2011). In late September 2010, an international team that included this author visited Tibet to study the reported andesine occurrences in the Shigatse area (Abduriyim and Laurs, 2010; Abduriyim et al., 2010; Hughes, 2010; Leelawatanasuk, 2010). The team consisted of authors BML, AA, and FI, as well as Thanong Leelawatanasuk (Gem and Jewelry Institute of Thailand, Bangkok), Richard Hughes (Sino Resources Mining Corp. Ltd., Hong Kong), Christina Iu (M. P. Gem Corp., Kofu, Japan) and Young Sze Man (Jewellery News Asia, Hong Kong). They were guided by Li Tong (Tibet Andesine, Shenzhen, China), his wife Lou Li Ping, and their employee He Qung.

The group spent three days studying the reported Tibetan andesine occurrences at Zha Lin and Yu Lin Gu (Abduriyim and Laurs, 2010; Abduriyim et al., 2010; Hughes, 2010; Leelawatanasuk, 2010). These are located ~3 km from the Nai Sa–Bainang mining area that author AA visited in 2008. However, the party was unable to visit the Bainang mine, due to the objection of a local monk who controls access to the land in that area.

This article reviews the geologic setting of the Tibetan andesine localities and describes the fieldwork done by the expedition group.

Figure 1. These samples of andesine (4.45–10.85 ct), represented as being from Tibet, were selected to show the range of color of this material in the marketplace. Courtesy of Litto Gems; photo by Robert Weldon.

LOCATION AND ACCESS

The reported andesine deposits are located in Bainang County, ~55 km southeast of the region's second largest city, Shigatse (or Xigazê), in southern Tibet (figure 2 and table 1). All three localities (Nai Sa–Bainang, Zha Lin, and Yu Lin Gu) are situated within 2–3 km of one another (figure 3). They are located ~8 km southeast of Bainang town, near the villages of Zha Lin (Zha Lin and Yu Lin Gu localities) and Nai Sa (Bainang mine). From the capital city of Lhasa, it takes more than five hours to drive ~300 km to Shigatse on a paved road that crosses two passes at 4,900 and 5,088 m. From Shigatse, it takes another 1–2 hours to drive to the mining area on mostly paved roads. Foreigners are forbidden from visiting this area without authorization from both the Chinese government and local authorities.

Figure 2. The reported andesine mines visited by the authors' 2010 expedition are located in south-central Tibet, ~55 km from Shigatse. Also shown is another reported andesine occurrence in Gyaca County that was determined to be fake by Fontaine et al. (2010). The inset shows the locations of the reported Zha Lin, Yu Lin Gu, and Nai Sa–Bainang andesine localities in Tibet.

TABLE 1. Reported andesine deposits in Tibet.

Site	Coordinates
Bainang South	29°02.57'N, 89°22.17'E; 4,072 m (13,360 ft.)[a]
Bainang North	29°02.71'N, 89°22.18'E; 4,049 m (13,285 ft.)[a]
Zha Lin	29°03.95'N, 89°20.88'E; 3,929 m (12,891 ft.)
Yu Lin Gu	29°03.08'N, 89°20.76'E; 4,102 m (13,460 ft.)
Gyaca (Jia Cha) County, Shan Nan area[b]	29°08.07'N, 92°35.95'E; 3,400 m (11,155 ft.)

[a] Coordinates for the Bainang localities are from Wang (2011).
[b] Visited by GRS in 2009, but determined to be "salted."

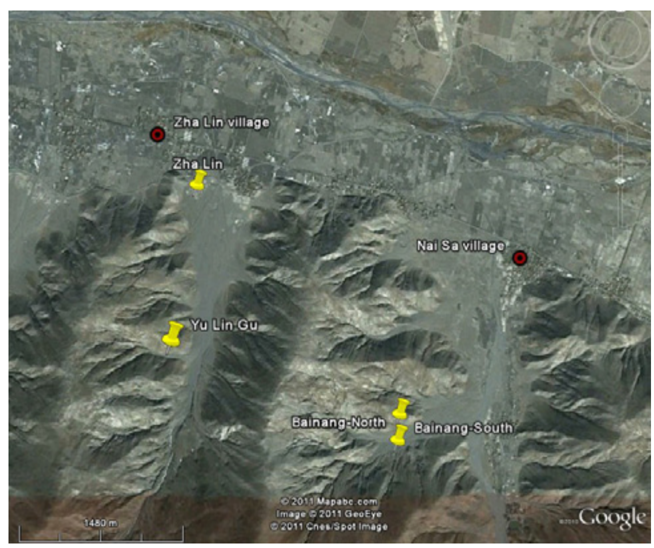

Figure 3. The Nai Sa–Bainang, Zha Lin, and Yu Lin Gu andesine occurrences are located near one another, as shown by the yellow symbols on this Google map.

GEOLOGIC SETTING

According to geologic studies of the Bainang area (e.g., Guilmette, 2008; see figure 4), the andesine mining area is underlain by Late Triassic (~220 million years ago [Ma]) sedimentary rocks called flysch (marine sediments deposited during the rapid erosion of an orogenic belt or mountain-building area). The flysch sediments

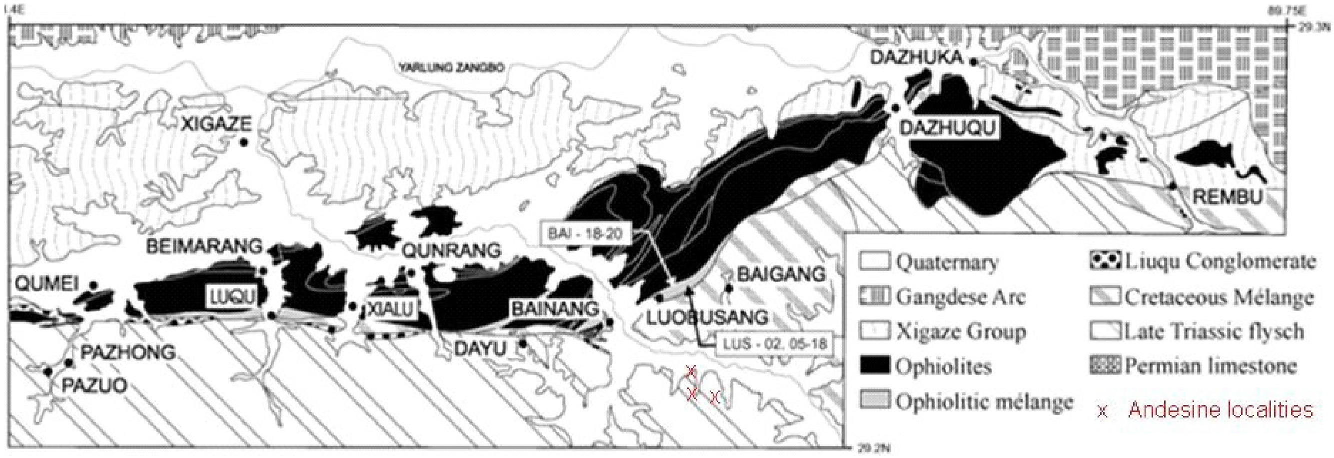

Figure 4. Tibetan andesine reportedly occurs in an area that is underlain by Late Triassic flysch (marine sedimentary rocks) according to this geologic map, modified from Guilmette (2008).

are located adjacent to Cretaceous mélange rocks and ophiolites (packages of mafic and ultramafic igneous rocks that are believed to represent former oceanic crust). All of these rocks lie along the Yarlung Zangbo suture zone, which formed as a result of the convergence of the Indian and Asian plates in early Cenozoic time. According to a geologic map published by the Chinese government (Qin Zang Gao Yuan..., 2005), the marine sediments consisted of dolostone and marble, sandstone, gravel, and shale, with local coal layers; however, this map indicated these sediments are mid-Tertiary in age (~30 Ma, much younger than Late Triassic). Our field observations indicated that the andesine is hosted by alluvial sediments weathered from sedimentary formations consisting mainly of shale, dolostone, and clay-rich sandstone that were locally cut by small quartz veins. The quartz was milky and rarely showed signs of drusy crystals; there were no associated minerals.

The Himalayan region of Tibet is structurally complex and experienced four major periods of uplift: 55–36, 25–20, 17–12, and 3–0 Ma, all of which are much younger than the flysch. Therefore, the present-day geomorphology of the area is probably much different than when the andesine was weathered from its original host rocks and incorporated into sediments derived from the flysch. It is unclear when or how the andesine would have been deposited into these sediments. Mechanical weathering of these rocks created alluvial fans and stream-deposited gravels that locally appear to contain the pebbles of andesine.

Of particular geologic interest is locating the original source rocks of the andesine. Based on the geology of similar gem feldspar from Oregon (labradorite megacrysts in basalt; Johnston et al., 1991), the andesine would be expected to form within an intermediate-to-mafic volcanic rock such as basaltic andesite. Another potential host rock is alkali basalt (e.g., Aoki, 1970). No such rocks were found in the vicinity of the andesine occurrences, either as outcrops or as clasts in the alluvial sediments. The Chinese geologic map mentioned above showed such rocks west of Shigatse (i.e., in the opposite direction as the reported andesine deposits). During a half-day excursion to this area, we encountered only sedimentary rocks on the north side of the main highway, and eventually found volcanic rocks within an alluvial fan on the south side of the road at 29°08.56'N, 88°44.94'E, elevation 3,918 m. Andesite was more abundant than basalt, and the basalt was very fine-grained and devoid of phenocrysts. We found no evidence of andesine megacrysts during our brief field visit.

The original host rocks for Tibetan andesine were not found during our expedition or during any previous andesine field studies (e.g., Abduriyim, 2009b; Wang et al., 2011). Therefore, if such rocks previously existed in the area, they must have been tectonically displaced and/or have weathered away.

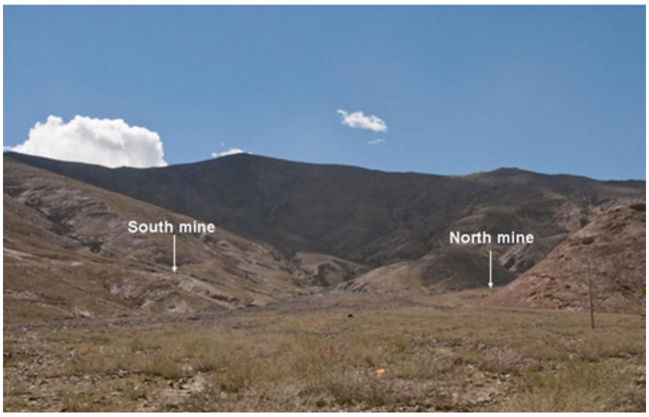

Figure 5. Two andesine occurrences are reported in the Nai Sa–Bainang area. The actual workings of the southern mining area are not visible from this position. Photo by B. M. Laurs.

FIELD STUDIES AND LOCAL GEOLOGY

Nai Sa–Bainang

Nai Sa is a small village located 3.5 km east-southeast of Zha Lin on the main paved road to Shigatse. The mining area is located ~2.2 km up the valley to the southwest of the village (figure 5), where there are two andesine localities (figures 6 and 7). The geologic occurrence of andesine at Nai Sa–Bainang was described by Abduriyim (2009b). Unfortunately, our group was forbidden from visiting the mining area by the resident lama at a nearby monastery.

We visited a home in Nai Sa village to view andesine from the Nai Sa–Bainang mine that had been collected by local villagers over the previous three years. We purchased samples from a total of ~10 kg of material that had been stockpiled. Various parcels consisted of dirty (reportedly mined from near-surface deposits) or clean (gathered from streambeds) andesine. According to Christina Iu (pers. comm., 2010), during the period of organized mining by Li Tong in 2005–2008, ~700 kg/year of andesine was produced by about 10 families working the deposit. Of this, only 3–5% was facetable and 20–30% was cabochon- and bead-grade.

The andesine samples we obtained in Nai Sa village were generally visually indistinguishable from those we collected at Zha Lin and Yu Lin Gu. Most were transparent to translucent rounded pebbles, and their overall gem quality was not high.

Zha Lin

From the village of Zha Lin we drove a few hundred meters south to the reported mining area, which was marked by series of shallow pits over an area measuring approximately 200 x 100 m. The site was located near the end of an elongate alluvial plain that was fed by a series of side valleys containing alluvial fans (including Yu Lin Gu, described below). Li Tong reported that from 2005 until the recent market collapse, 1–2 tonnes of andesine had been mined here. Although he did not work the deposit himself, he purchased the andesine directly from the local villagers. We saw no evidence of recent digging during our visit.

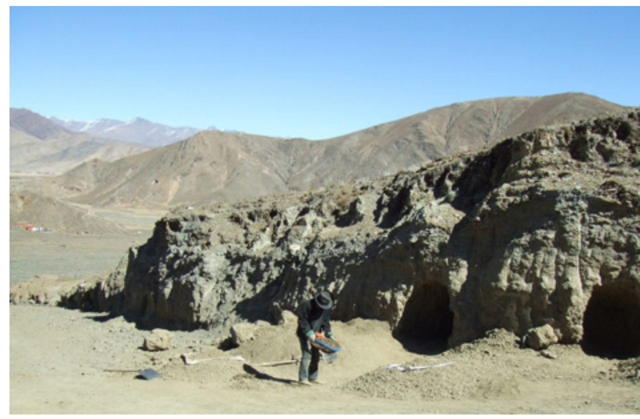

Figure 6. At Nai Sa–Bainang's southern mining area, andesine was mined from a dark gray sediment layer. Photo by A. Abduriyim, November 2008.

Figure 7. The northern mining area at Nai Sa–Bainang was impacted by an earthquake in 2008. Andesine was reportedly mined from reddish yellow soil mixed with boulders. Photo by A. Abduriyim, November 2008.

At Zha Lin, we found andesine on the surface and at depth in gray silty sediments underlying a layer of more recent alluvial material (figures 8 and 9). Our first pit (1.2

m deep) was dug in the former mining area and produced several pieces of andesine (e.g., figure 10). Next we randomly selected three areas upstream from the former mining area and dug pits in undisturbed ground under slow-growing thorn bushes (figure 11). At the first pit, andesine was found near the surface and on down to a depth of 30 cm, where we stopped digging. A second random pit (dug to 20 cm depth), located further from the mined area, produced no stones. A third random pit (dug to ~25 cm depth), located closer to the mined area, yielded a few andesines, with the first piece found at 10 cm depth. A final pit dug in the formerly mined area (to ~70 cm depth) yielded several stones. The andesine was hosted by a gray silty soil layer of an alluvial plain that

Figure 10. At Zha Lin, andesine was found within moist silty sediments. Photo by B. M. Laurs.

Figure 8. At Zha Lin, andesine was said to be mined from shallow pits such as those shown here. Photo by B. M. Laurs.

Figure 9. Several andesines were recovered from this pit that was dug in the former mining area at Zha Lin. Photo by B. M. Laurs.

Figure 11. Andesine pebbles were found in a 30-cm-deep pit that was dug under this thorn bush at a random location above the Zha Lin mining area. The Yu Lin Gu occurrence is located up-valley around the right side. Photo by B. M. Laurs.

was locally overlain by more recent alluvial fan deposits. The silty matrix contained variable amounts of rounded shale and mudstone clasts.

During the latter part of our sampling, local villagers arrived and some showed us small parcels of andesine that they had reportedly found in this mining area. This material looked identical to what we found ourselves.

We noticed small excavations in the surrounding hillsides above the valley floor, but the villagers indicated that these were not associated with andesine. Instead, these pits and trenches were probably quarries for building material.

Figure 12. The Yu Lin Gu andesine occurrence is located on the alluvial fan seen in the middle of this image, looking down-valley toward Zha Lin. Photo by B. M. Laurs.

Figure 13. Scattered pieces of andesine were found laying on the surface of the alluvial fan at Yu Lin Gu. Photo by B. M. Laurs.

Yu Lin Gu

This andesine occurrence is located ~2 km south of Zha Lin village, on an alluvial fan extending up the west side of the main valley (figures 12 and 13). A poor dirt track leads ~1 km from Zha Lin, and the next 1 km was navigated by driving "cross-country" using 4WD up the valley to the base of the fan. Andesine from Yu Lin Gu was reportedly first gathered in September 2008, but neither Li Tong or author AA were aware of it during their late-2008 visit to Tibet. No organized mining has taken place; stones only have been picked up from the surface. Local people have reportedly gathered ~200 kg andesine from the surface; there was no evidence of any excavations.

We found scattered pieces of andesine laying on the surface, starting about half-way up the fan and continuing up two drainages toward the top of the fan. It was locally concentrated in patches consisting of 4–10+ pieces per square meter. One place had two pairs of andesines lying on top of one another (figure 14). The majority of the andesine was found on raised portions of the fluvially dissected alluvial fan. In addition, several pieces were collected from an active intermittent creek on the north side of the fan. Unlike the rest of the clasts in the streambed, the andesine was relatively clean and not covered with as much algae as the rest of the streambed (figure 15). All of the andesine possessed a similar rounded appearance that appeared to be due to alluvial transport (rather than chemical etching), even though it was hosted within little-transported alluvial fan debris consisting of soft sedimentary rocks (and rare quartz vein material). We dug several shallow pits below areas containing andesine on the surface (e.g., figure 16), but no pieces were found below a loose silty layer (<2 to rarely 10 cm thick) at the surface.

Pieces of andesine were traced upslope into two narrow ravines toward the top of the alluvial fan, but careful searching above those points yielded no additional pieces. There were no changes in the local geology in the areas where andesine ceased to be found.

Figure 14. Two pairs of stacked andesines are shown as they were found on the ground at Yu Lin Gu. Photo by B. M. Laurs.

Figure 15. Andesine pebbles such as this one were seen in an intermittent creek on the Yu Lin Gu alluvial fan. Photo by B. M. Laurs.

We also explored the main alluvial valley adjacent to the Yu Lin Gu fan for signs of andesine or potential host rock material. Author AA found one piece of andesine next to a goat herder's trail on the west side of the valley at 29°03.45'N, 89°20.91'E, elevation 3,986 m. Author FI investigated an alluvial fan on the opposite (east) side of the valley, but found no andesine or potential host rock occurrences.

Figure 16. Alluvial material was screened from shallow pits dug into the Yu Lin Gu alluvial fan, but no andesine was found at depth. Photo by B. M. Laurs.

DISCUSSION

The 2010 expedition described in this report was unable to reconfirm the geologic occurrence of the Nai Sa–Bainang andesine mining area since they could not obtain permission to visit there.

At Zha Lin, the discovery of andesine within pits dug in random, previously unexplored areas near the former reported mining area is consistent with what would be expected for a genuine andesine deposit. It is difficult to imagine a scenario in which such samples could have been placed there by human intervention. In addition, the presence of the andesine pebbles within sediments of a distal alluvial plain (rather than an alluvial fan) is more consistent with their degree of rounding. However, some of these samples showed glassy surface residues (see the accompanying Abduriyim et al. [2011] *Gems & Gemology* article), and the origin of these residues cannot currently be explained. Nevertheless, three samples (without surface residues) had argon isotopic values that showed they had not undergone heat treatment (see the accompanying Abduriyim et al. [2011] article).

At Yu Lin Gu, expedition members only found samples at, or very near, the surface of an active alluvial fan. Because such samples could have been intentionally placed there (i.e., "salted"), the 2010 expedition could not verify the authenticity of the deposit. Indeed, several aspects of the occurrence of andesine in this area aroused suspicion:

- This active alluvial fan consisted of fragments (many quite angular) of relatively soft sedimentary rocks or pieces of quartz veins, all of which were locally derived by mechanical weathering. The rounding of the relatively hard andesine is inconsistent with the incipient amount of rounding shown by the rest of the soft sedimentary alluvial material. Also, there was no evidence of any expected andesine source rocks in the fan material.
- The presence of andesine only on localized parts of the surface of an alluvial fan is not consistent with transport of material in an alluvial fan environment. A more even distribution of the andesine throughout the alluvial fan, and at various depths within the fan material, would be expected for such transport. The abrupt disappearance of andesine in drainages toward the upper end of the alluvial fan—without any corresponding change in the local geology—is not geologically explainable.
- The local abundance of andesine on the fan (with instances of two pieces lying on top of one another) was surprising, particularly for an area that had reportedly been collected by local people.
- In the intermittent stream, the presence of andesine that was relatively free of algae compared to the rest of the material in the streambed gave the appearance that it had been dropped there recently before our visit.
- Many of the andesine pebbles in the stream were found lying on much finer-grained sediments and therefore showed major inconsistencies with the fluvial energy of the local depositional environment.

As with the andesine collected at Zha Lin, some of the material from Yu Lin Gu contained glassy surface residues that cannot currently be explained. However, two samples (without surface residues) had argon isotopic values that showed they had not undergone heat treatment (see the accompanying Abduriyim et al. [2011] article). If andesine pebbles were scattered on the ground at Yu Lin Gu by someone, it appears that some (or all) of it was untreated.

In the absence of any known host rocks for andesine in Tibet, it would be helpful to obtain radiometric age data for the andesine itself (i.e., on samples such as those showing high levels of radiogenic argon that are reported in the accompanying Abduriyim et al. [2011] article). This would help constrain the search for possible host rocks based on the geologic evolution of the southern Tibetan Plateau according to its tectonic history and volcanism (e.g., Searle et al., 2011; Xia et al., 2011). A comparison of the age data to that of pale yellow andesine from Inner Mongolia would also be of interest.

CONCLUSIONS

The authors' 2010 expedition visited two reported Tibetan andesine occurrences, Zha Lin and Yu Lin Gu, located near the previously investigated Nai Sa–Bainang mining area. The samples obtained by the team showed an overall low quality compared to the abundance of attractive gems represented as Tibetan in the marketplace. Such material was mostly not facetable and would be best used for beads (e.g., figure 17). Our team found strong field evidence for a genuine andesine deposit at Zha Lin, but could not confirm the authenticity of the Yu Lin Gu occurrence. Both areas consist of alluvial material derived from the weathering of marine sedimentary rocks. No primary andesine-bearing source rocks were found in either area, and the original source of the andesine remains unknown. It is possible that andesine could have formed in adjacent terranes that have been displaced by tectonic activity and/or weathered away. A more thorough geologic investigation of the region, combined with radiometric age dating of the andesine and potential host rocks exposed elsewhere in the Shigatse area, could help explain the origin of this material.

Figure 18. The faceted beads in these strands were cut from andesine that was reportedly gathered at Yu Lin Gu. The strands contain 104–223 carats of andesine, and the cut stone (showing distinct color banding) weighs 5.27 ct. Courtesy of Sapphex Pty. Ltd.; photo by Robert Weldon.

ACKNOWLEDGMENTS

The authors are grateful to Christina Iu (M.P. Gem Corp., Kofu, Japan) for supporting and organizing the field trip, and to miner Li Tong and his wife Lou Li Ping (Tibet Andesine, Shenzhen, China) for allowing access and guiding us to the localities.

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Note: This report accompanies the following article: Abduriyim A., McClure S.F., Rossman G.R., Leelawatanasuk T., Hughes R.W., Laurs B.M., Lu R., Isatelle F., Scarratt K., Dubinsky E.V., Douthit T.R., Emmett J.L. (2011) Research on gem feldspar from the Shigatse region of Tibet, *Gems & Gemology*, Vol. 47, No. 2, pp. 167–180.