Visit to andesine mines in Tibet and Inner Mongolia. Gem-quality plagioclase feldspar (labradorite) has been recovered for years from the U.S. state of Oregon (e.g., A. M. Hofmeister and G. R. Rossman, “Exsolution of metallic copper from Lake County labradorite,” Geology, Vol. 13, 1985, pp. 644–647; C. L. Johnston et al., “Sunstone labradorite from the Ponderosa mine, Oregon,” Winter 1991 Gems & Gemology, pp. 220–233). In 2002, red andesine-labradorite appeared in the gem market that was reportedly sourced from an unspecified locality in the Democratic Republic of the Congo (Spring 2002 GNI, pp. 94–95), but some believe that this material actually came from China. In late 2005, a red andesine called “Tibetan sunstone” was supplied by Do Win Development Co. Ltd. of Tianjin, China, reportedly from Nyima (actually Nyemo) in central Tibet (Winter 2005 GNI, pp. 356–357). Then, at the February 2007 Tucson gem shows, King Star Jewellery Co. (Hong Kong) and M. P. Gem Corp. (Kofu, Japan) introduced a similar red andesine from Tibet called “Lazasine.” A large supply of red andesine allegedly from China was offered for sale as an official gemstone of the 2008 Summer Olympic Games in Beijing. Despite claims to the contrary, there has been widespread suspicion that the red Chinese andesines are diffusion treated. In fact, recent studies have proved the viability of diffusion-treated such material (e.g., G. Roskin, “JCK web exclusive: The andesine report,” posted November 12, 2008, www.jckonline.com/article/CA6613857.html).

In October-November 2008, this contributor visited two andesine deposits in the Chinese autonomous regions of Tibet and Inner Mongolia. The investigation was made possible by the cooperation of mine owners Li Tong of Tibet and Wang Gou Ping of Inner Mongolia, as well as trip organizers Wong Ming (King Star Jewellery Co.) and Christina Lu (M. P. Gem Corp.), who are partners in the Tibetan andesine mine. Also participating in the expedition were Masaki Furuya (Japan Germany Gemmological Laboratory, Kofu, Japan), David Chiang (BBJ Bangkok Ltd., Bangkok), and Marco Cheung (Litto Gems Co. Ltd., Hong Kong).

The Tibetan andesine mine we visited is located 70 km south of the region’s second largest city, Xigazê (or Shigatse), in southern Tibet. This area is well south of the Nyima/Nyemo area (Lhasa region), and our guides were not aware of an andesine mine in that part of Tibet. We drove seven hours from the capital city of Lhasa to the mine, which lies at an elevation of more than 4,000 m. The site is divided into north and south areas with a total coverage spanning 3–4 km east-west and 5–7 km north-south. During our visit, fewer than 10 miners were digging pits in the south area, near a piedmont riverbed (located at the base of a mountain). Organized mining began there in January 2006 under the supervision of Li Tong. The work is done by hand, from April to November. According to the miners, red andesine was originally found in this area in the 1970s, and beads of this material first appeared in Lhasa’s largest bazaar (Bakuo Street) in 2003.

The surface layer at the site consists of humic soil that is 0.5–3 m thick. The andesine is mined from an underlying layer consisting of greenish gray or dark gray sand/gravel in the south area (figures 1 and 2), and yellowish red or greenish gray soil in the north area. The andesine-bearing layers are apparently derived from Tertiary volcano-sedimentary
deposits (Qin Zang Gao Yuan [Tibet Highland] area geologic map, Chengdu Institute of Multipurpose Utilization of Mineral Resources, China Geological Survey, Chengdu, Sichuan Province, 2005). In the south mining area, a few tunnels penetrate several meters horizontally into the andesine-bearing horizons. In addition, a shaft was sunk several meters deep in the north area, but mining there was discontinued after the devastating Chengdu earthquake in May 2008. The andesine is concentrated in patches consisting of several to more than a dozen pieces (100–200 g total) mixed with sand/gravel or soil (again, see figure 2). These accumulations appear to have been concentrated across a wide area by water from seasonal snowmelt.

Alluvial transport has rounded the crystals, and most were found as translucent to transparent pebbles that were <1 cm in diameter (figure 3), though the largest pieces reached 4 cm. Most were orangy red; deep red material was less common. Some had areas that were green or colorless, but we did not see any pieces that were completely brown, yellow, or colorless. The annual production from the region is estimated to be 700–800 kg, of which 30–50 kg are gem
Gemological properties of andesine collected in Tibet and Inner Mongolia. While visiting andesine mines in Tibet and Inner Mongolia (see previous GNI entry), one of these contributors (AA) obtained several samples for gemological study that he witnessed being gathered by the miners. Ten pieces (up to 26.0 g; see, e.g., figure 6) from each region were polished with two parallel windows, and all were characterized for this report. It is currently impossible to unequivocally determine in the laboratory whether red andesine in the gem trade has been diffusion treated. This preliminary characterization was done to gather data on red samples that are known to be untreated, as well as pale yellow material that may be used as a starting material for diffusion treatment.

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All the samples had a waterworn appearance, and some of the Tibetan pebbles also had embayed areas that appeared to have been created by chemical etching (figure 7). The pebbles from Inner Mongolia also were abraded, but they were more angular than the Tibetan samples and exhibited conchoidal fractures.

The Tibetan samples had the following geological properties: color—brownish red to orange-red to red; pleochroism—weak; RI—1.550–1.561; birefringence—0.009; optic sign—biaxial positive; SG—2.69–2.72; fluorescence—orange to long-wave, and dark red to short-wave; UV radiation; and Chelsea filter reaction—red. The Inner Mongolian samples were pale yellow, but otherwise they exhibited almost identical properties except that they were inert to both long- and short-wave UV radiation, and they showed no reaction to the color filter.

Examination with a geological microscope revealed that most of the Tibetan samples contained prominent twin lamellae and parallel lath-like hollow channels (figure 8, left), irregular dislocations (figure 8, right), and irregular color patches caused by milky turbidity from fine granular inclusions (figure 9). One of the polished samples displayed avenescence due to the presence of native-copper platelets. The samples from Inner Mongolia contained parallel flat growth tubes (figure 10, left), as well as abundant linear fissures (figure 10, right) and fine twin planes arranged parallel to a (010) direction. In some cases, the linear fissures caused a weak opalescence, and such stones cut en cabochon would be expected to show a weak cat’s-eye effect. Cleavage planes were also well developed along one (010) direction.

Absorption spectra were measured with a UV-Vis spectrometer in the range 220–860 nm. The Tibetan andesine exhibited absorption from 320 nm toward shorter wavelengths, as well as a prominent broad band near 565 nm due to colloidal copper. In addition, a weak feature near 380 nm was due to Fe$^{3+}$. Similar absorptions have been documented in red andesine that was reportedly from the Democratic Republic of the Congo and in red labradorite from Oregon (A. M. Hofmeister and G. R. Rossman, “Exsolution of metallic copper from Lake County labradorite,” Geology, Vol. 13, 1985, pp. 644–647; M. S. Krzemicki, “Red and green labradorite feldspar from Congo,” Journal of Gemmology, Vol. 29, No. 1, 2003, pp. 15–23). Spectroscopy in the near-infrared region (800–2500 nm) revealed an absorption peak near 1260 nm that is caused by Fe$^{3+}$.

The andesine from Inner Mongolia showed absorptions at 380, 420, and 450 nm. The 380 nm feature was strongest, while the broad band at 420 nm (presumably due to charge transfer between Fe$^{2+}$ and Fe$^{3+}$) was characteristic. A strong and broad absorption also was observed near 1260 nm.

Energy-dispersive X-ray fluorescence (EDXRF) chemical analysis of andesine from both Tibet and Inner Mongolia revealed very similar compositions, with 55–56 wt.% SiO$_2$, 26–27 wt.% Al$_2$O$_3$, 10 wt.% CaO, and 5.8–6.2 wt.% Na$_2$O. Trace elements such as K, Mg, Ti, Fe, and Sr were detected. The Tibetan stones also contained 0.06–0.10 wt.% CuO, but no Cu was detected in the Inner Mongolian samples. The chemical composition showed that all samples were andesine, with some plotting at the border with labradorite (An$_{47-50}$). Previous electron microprobe analyses of samples from Inner Mongolia showed they were labradorite, with a composition of An$_{50-51}$ (or An$_{50-53}$ if K is excluded; Y. Cao, “Study on the feldspar from Guyang County, Inner Mongolia and their color enhancement,” Master’s thesis, Geological University of China, 2006).

Laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) analysis showed that samples from

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Figure 7. Surface etching was observed on some Tibetan andesine pebbles. Photomicrograph by A. Abduriyim; magnified 28x.
both localities contained several trace elements: K (2200–3600 ppm), Fe (1000–3200 ppm), Sr (700–1000 ppm), Mg (330–620 ppm), Ti (400–510 ppm), Ba (120–160 ppm), Mn (20–40 ppm), Ga (20–30 ppm), Li (10–60 ppm), and Sc (5–15 ppm); B, V, Co, Zn, Rb, Sn, Ce, and Eu were <3 ppm each. No significant elemental difference was observed between Tibetan and Mongolian andesine, other than Cu content: 300–600 ppm in orangy red andesine, and <3 ppm in pale yellow andesine. In addition, Li was slightly dominant in Tibetan andesine.

Additional images from this study can be found in the G&G Data Depository at www.gia.edu/gemsandgemology.

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New find of vivid kunzite from Pala, California. In July 2008, several etched crystals of gem-quality kunzite were found at the historic Elizabeth R mine, located on Chief Mountain in the Pala District of San Diego County (see, e.g., Fall 2001 GNI, pp. 228–231). In mid-2008, Jeff Swanger (Escondido, California) purchased the mine from Roland Reed (El Cajon, California). Mr. Reed has continued to work the Elizabeth R while Mr. Swanger mines the neighboring Ocean View property, where he found a large gem pocket in 2007 (see Spring 2008 GNI, pp. 82–83).

Although this was not the first kunzite discovery at the Elizabeth R, these pieces had a particularly vibrant pinkish purple to pink-purple color that is seldom seen in natural-color kunzite (e.g., figures 11 and 12). Mr. Reed believes they compare favorably to kunzite from the nearby Vandenberge mine, which produced colors that are considered among the finest found anywhere. Approximately 0.5 kg of top-grade material has been recovered, and the best pieces were sent for fashioning to Minas Gem Cutters of Los Angeles. So far 11 stones have been cut, and the two largest ones weighed 57 and 28 ct. The cut material is being sold through Pala International (Fullbrook, California).

The samples shown in figure 12 were examined microscopically by this contributor. The few internal features were typical for kunzite: elongated, tapered etch tubes; and two-phase (liquid and gas) inclusions—either alone, in parallel, or in a “fingerprint” pattern with irregular to rounded elongate shapes. No mineral inclusions were seen. One faceted stone contained very slight cleavage feathers on the pavilion, while the rough piece showed typical shield-shaped etch marks on its surface.

Kunzite is challenging to cut because of its cleavage, twin planes, and sensitivity to vibrations and thermal shock. It also has a reputation as an “evening” gem, since its color fades with prolonged exposure to light or heat. Kunzite can naturally show an attractive color, as in this new find from the Elizabeth R mine, or the purple-pink hue can be produced by irradiating (and annealing) pale or colorless spodumene. Most natural-color kunzite is light pink. This new production from Pala serves as a reminder that gem mining is still active in San Diego County, where kunzite was initially discovered more than 100 years ago.

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