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Observations of Surface Residue Features Found on Andesine from China

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Abstract

Unusual glassy materials filling crevasses and low areas in rough samples of andesine from China have given rise to questions relating to the natural or treated origin of these feldspars. Of particular interest is the fact that the chemistry and nature of these "residues" is very similar in known treated stones and stones said to be natural from Tibet. This report examines this issue and the residues and makes some comparisons with natural feldspar from Oregon in which some surprising similarities can be seen.

INTRODUCTION

In the study of andesine from China, a main focus has been to try and determine if red stones reportedly coming from Tibet are authentic. As part of this investigation a number of factors have been investigated. One of those factors has been to determine the nature and origin of glassy residues found on the surface of rough from this locality.

Observations

Microscopic observation of the samples from all three reported Tibetan localities, as well as the known-treated Mongolian andesines, revealed unusual surface residues in the fractures, cavities, and depressions of many specimens, as reported previously in red andesine from Tibet or "China" (e.g., Abduriyim, 2009b; Lan et al., 2009; Rossman, 2011). However, many of the samples studied (~80–85%), whether Tibetan or known treated, did not show any residues, and they were not present on any of the pale yellow andesine from Inner Mongolia. Of the six specimens examined by this author that were dug from two random holes above the main mining area in Zha Lin, three had these glassy residues in depressions or cavities (figure 1). In addition to these six significant specimens, hundreds of samples were examined from both Tibet and Mongolia that were acquired from many different sources, including dealers, miners, concerned members of the trade and those collected on two separate expeditions to Tibet – either personally collected by the expedition members or acquired from the local people at the site.

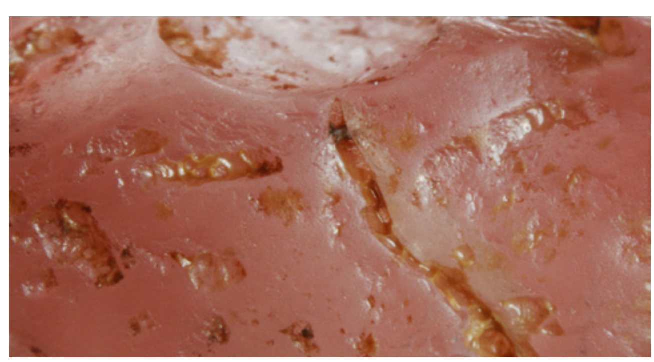

Figure 1 – Three of the six important specimens dug by the latest expedition from two random holes above Zha Lin, Tibet, had residues present in surface channels and cavities. Photomicrograph by S. F. McClure. Field of view 7.0mm

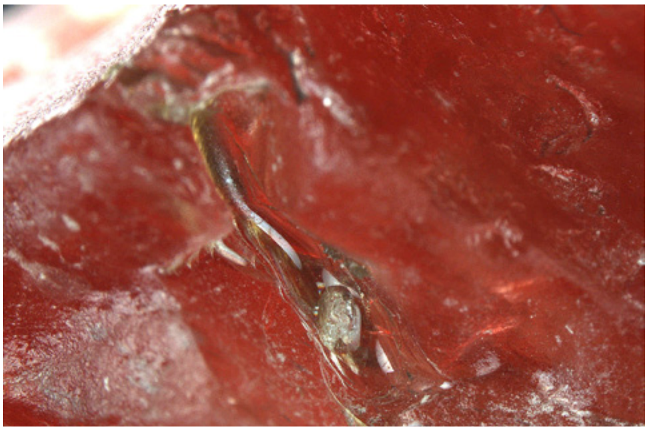

Figure 2a – This image shows and example of a transparent brownish orange residue filling a wide cavity. Known treated sample from Inner Mongolia. Photomicrograph by S. F. McClure. Field of view 2.9mm

Figure 2b – An example of a dark brown, almost opaque residue. Known treated sample from Inner Mongolia. Photomicrograph by S. F. McClure. Field of view 1.4mm

Figure 2c – A translucent yellow residue filling a depression in another stone. Sample collected from random pit near Zha Lin, Tibet. Photomicrograph by S. F. McClure. Field of view 1.2mm

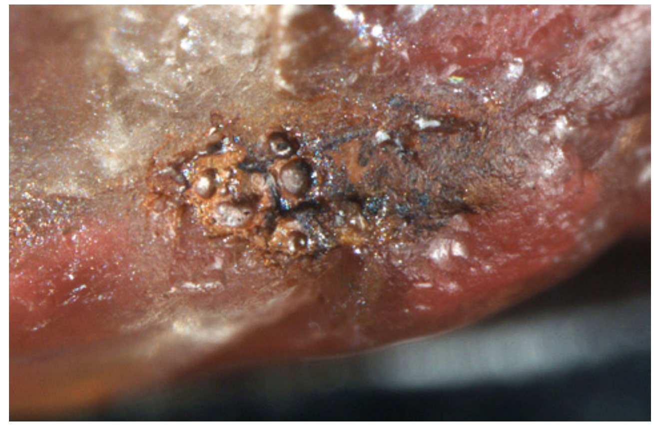

Figure 2d – Opaque orange and black residue with large bubble-like voids. Sample from pit in mining area near Zha Lin, Tibet. Photomicrograph by S. F. McClure. Field of view 2.0mm

The residues ranged from transparent to translucent and were colorless/white, yellow, orange, brown, or black (figure 2). Microscopic examination of these residues typically showed characteristics of a viscous liquid that filled low areas and then solidified: a meniscus against the feldspar, columns of this material bridging gaps in the feldspar (figure 3), and gas bubbles. Dendritic or platelet-like formations of a metallic material were sometimes visible in the residues (figure 4). In one instance we found two deep etch tubes partially filled with a transparent colorless glassy substance (figure 5). A flat facet polished across the tubes showed the filler to have a lower luster than the feldspar host (figure 6) and the chemistry was very similar to the glassy residues on the surface of these stones.

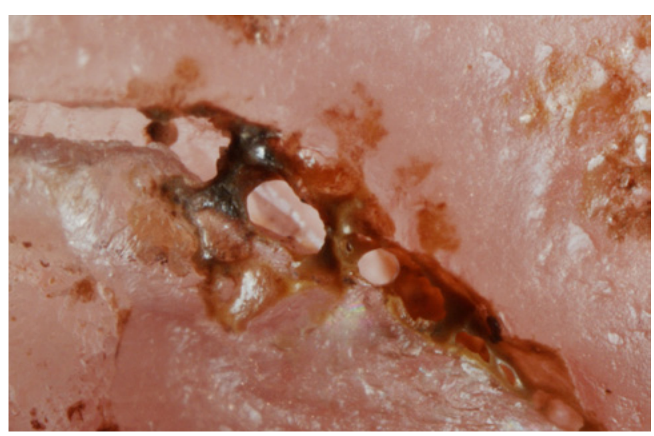

Figure 3 – Sometimes residues can be seen bridging gaps in the surface of the feldspar. Sample collected from random pit near Zha Lin, Tibet. Photomicrograph by S. F. McClure. Field of view 1.5mm

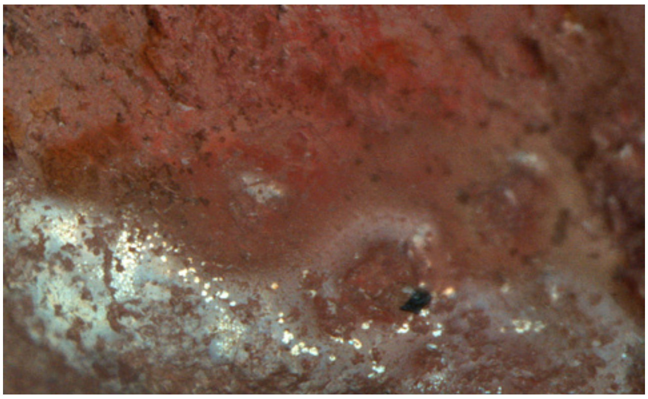

Figure 4 – Metallic platelets are visible just under or on the surface of the glassy residues present on some specimens. At the time of this publication the extremely small size of these platelets had prevented us from identifying them. This illustration also shows how the residues often resemble a liquid on the surface of the stone. Sample collected in Bainang during 2008 expedition. Photomicrograph by S. F. McClure. Field of view 0.9mm

On both the Tibetan and known-treated stones, the glassy residue sometimes cemented small fragments of feldspar to the surface of the andesine, as documented previously (Rossman, 2011) (figure 7). Also seen were small fragments of quartz attached to the surface with a material identified by Raman analysis as amorphous silica (figure 8). It is interesting to note that the fragments of quartz were sharp edged and did not have any wear indicating they had been in an alluvial environment. In another instance we saw a black metallic substance cemented to the surface of a known treated stone with a yellow residue (figure 9). Chemical analysis of these materials showed the yellow residue to be very similar to all the other residues we had tested, but the black metallic substance was much higher in Fe and Ti. Ni, while in trace amounts, was approximately eight times higher than the typical values for the residues (400ppmw vs. approx. 50ppmw). Given its appearance this makes sense, but exactly what it is we do not know.

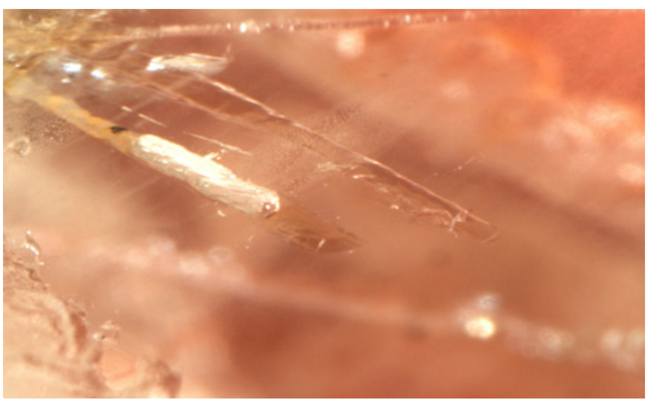

Figure 5 – Two growth tubes that were cut across when polishing a facet on a rough stone from Zha Lin turned out to be filled with a transparent colorless filler and were very low relief except for the bright area in left center that was a large gas bubble in the filler. Sample collected from random pit near Zha Lin, Tibet. Photomicrograph by S. F. McClure. Field of view 1.5mm

Figure 7 – Three pieces of yellow feldspar are cemented to the surface of this andesine by an opaque black metallic substance. Known treated sample from Inner Mongolia. Photomicrograph by S. F. McClure. Field of view 1.7mm

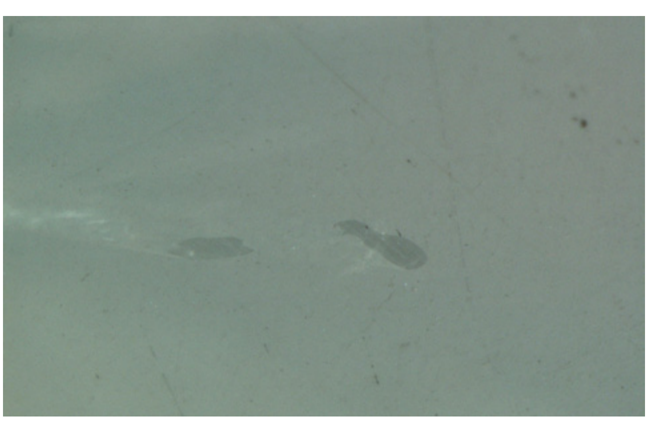

Figure 6 – Reflected light showed the filler in these etch tubes to have a lower surface luster than the surrounding host. Photomicrograph by S. F. McClure. Field of view 1.5mm

Figure 8 – Sharp edged quartz fragments were fused to the surface of some of the andesines with amorphous silica. Sample collected from random pit near Zha Lin, Tibet. Photomicrograph by S. F. McClure. Field of view 2.0mm

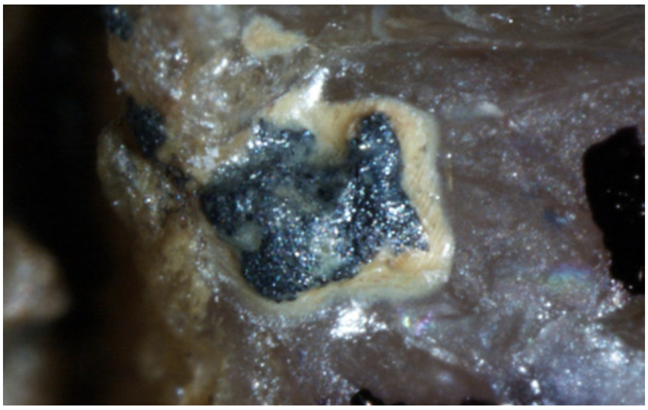

Figure 9 – On another stone, an opaque black metallic substance was attached to the surface with a glassy translucent yellow material. Sample said to have been collected at Bainang by a villager. Photomicrograph by S. F. McClure. Field of view 1.2mm

The chemistry for all these residues and other materials fused to the surface of these andesines were analyzed using LA-ICP-MS. It is important to note that in all cases most of the major elements detected were those expected to be found in feldspar: Si, Al, Ca, Na, and K, in average order of abundance. Fe was also often present in major amounts but not always. Other elements in which significant amounts were often present were Mg, Cu and to a lesser extent Ti. In addition, more than 30 other elements were usually present in trace amounts above 1ppmw.

Exact numbers are not being given here in most cases because LA-ICP-MS is not a technique intended to measure major elements in that way, making the numbers potentially subject to very large uncertainties. However, the relative ratios of these numbers can be used to illustrate chemical differences of materials. For example, the black metallic substance mentioned above had a much higher Fe and Ti content than the yellow substance holding it to the feldspar. In this case they were approximately 3 to 5 times higher than the average Fe content of all the residues measured.

Most of the Raman spectra we acquired on the residues did not match anything in our database. On a few samples, particularly in some dark areas, we obtained a good match with amorphous carbon (figure 10). The chemistry of these residues was consistent between all of the Tibetan and known-treated samples that were analyzed. In agreement with the findings of Rossman (2011), all the residues had relatively high levels of potassium and copper compared to the feldspar itself, with trace amounts of numerous other elements.

So what are these residues? At first glance it seems very hard to explain their presence on untreated stones. On a treated stone it is easy to imagine a flux or other medium present in a crucible during heating melting and flowing into the low areas on a piece of rough. Glassy residues created this way are common in some gem materials such as corundum. However, on an unheated stone, in this case feldspar, such residues seem very hard to explain.

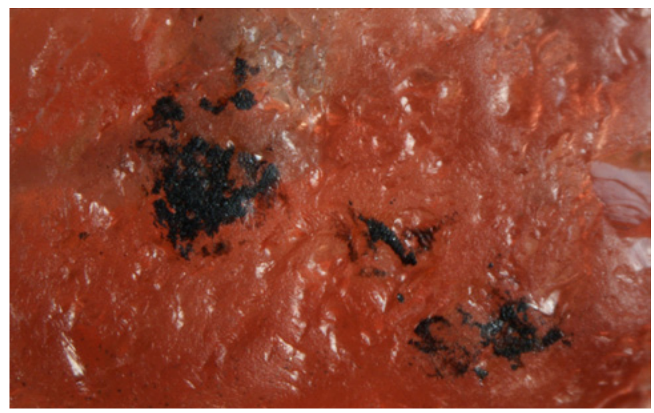

Figure 10 – Raman analysis showed black patches on the surface of some stones to be amorphous carbon. The significance of this fact is unclear. Sample from pit in mining area near Zha Lin, Tibet. Photomicrograph by S. F. McClure. Field of view 1.4mm

Plagioclase feldspar forms in relatively high temperature environments, so the thought had occurred to us that maybe something could be happening in this environment to create the glassy residues on the material that was supposed to be unheated. Several years ago this author visited the Oregon sunstone mines and returned with hundreds of samples of that material. Oregon sunstone is copper-bearing natural labradorite similar in composition to the Tibet andesine. A survey of this material, paying attention to anything adhering to the surface or filling cavities or channels, produced some very interesting observations.

The Oregon feldspar – particularly stones from the Ponderosa mine – often has a reddish or brownish material (probably partially oxidized basalt) adhering to the surface of the rough stones when they are first recovered.

Tumbling the stones in water for a few hours removes some of this material, but there is often some remaining. It's this material we examined to see if any similarities to the Tibetan material existed. Surprisingly, some did.

The surface material is mostly opaque, but spherical bubble-like structures within it are quite common (figure 11).

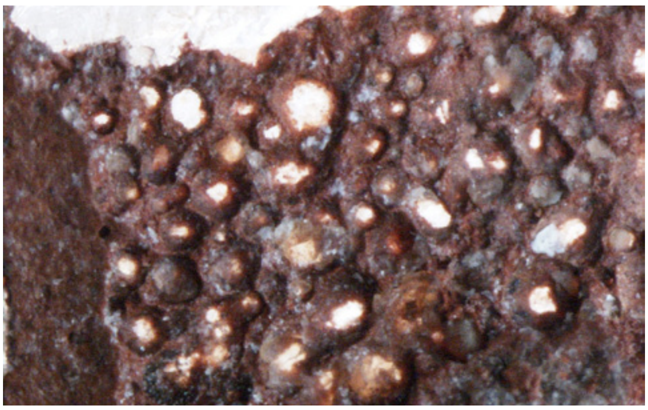

Figure 11 – While not exactly the same appearance as the material found on the andesines, matrix with bubble-like structures were commonly seen on natural feldspar rough from Oregon. Photomicrograph by S. F. McClure. Field of view 2.9mm

Some areas on a few stones had a shiny, somewhat glassy looking appearance in depressions (figure 12). There were also some areas where the material was bridging gaps in the feldspar (figure 13) and filling crevasses and low areas (figure 14) in a very similar manner to the Tibetan feldspar. There were even some areas that had a coppery metallic appearance (figure 15). However, no transparent substances were found to be filling crevasses or cavities in the Oregon feldspar and it never approached the glassy appearance of the Tibetan andesine. In addition, we saw nothing in the Oregon stones even remotely similar to the quartz and feldspar fragments fused to the surface of the Tibetan feldspar.

Raman analysis of these features yielded no matches but if these materials are comprised of multiple minerals [or natural glasses] this is not surprising.

The chemistry of the surface deposits on the Oregon material had some significant differences to the residues found on the Tibetan stones. They contained much higher Fe (2 times) and Mg (3 to 4 times) and lower levels of K and Cu (both approx. 10 times less). This is consistent with the chemistry one might expect for matrix in basaltic deposits such as this.

Obviously the material found on the surface of the Oregon feldspar is different in many respects from the residues found on the Tibetan andesine. However, the fact that some similarities were found means that the possibility exists there is a natural explanation for at least some of these "residues" we have been seeing.

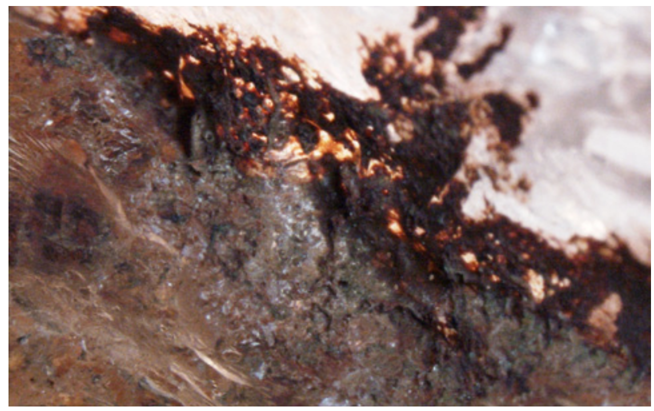

Figure 12 – Shiny areas were found in depressions on some of the pieces of natural rough feldspar from Oregon. Photomicrograph by S. F. McClure. Field of view 2.5mm

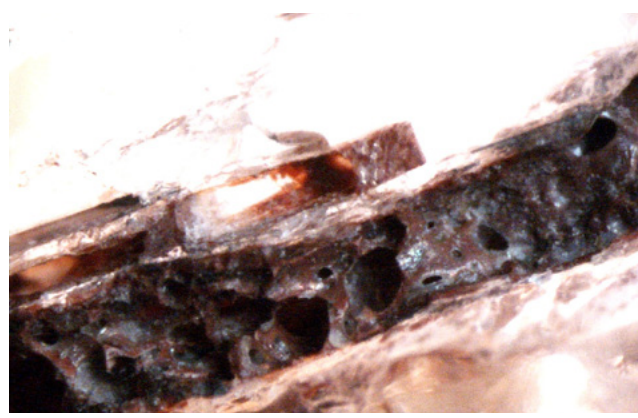

Figure 13 – Glassy dark brown translucent material could be seen bridging gaps in some of the natural Oregon feldspar rough. Photomicrograph by S. F. McClure. Field of view 1.2mm

Regardless of all this, there are still some significant things about the Tibetan residues that are hard to explain. The chemistry of the residues in the Tibetan material does not make much sense and very glassy transparent areas are troublesome. It is hard to imagine how fragments of feldspar and quartz came to be fused to the surface of some of these stones via some kind of natural process. Perhaps most disturbing of all (at least to this author) is the fact that the chemistry and general appearance of the residues in the Tibet stones are very similar to those found on known- treated stones from Inner Mongolia. As of yet there has been no plausible explanation suggested for this fact.

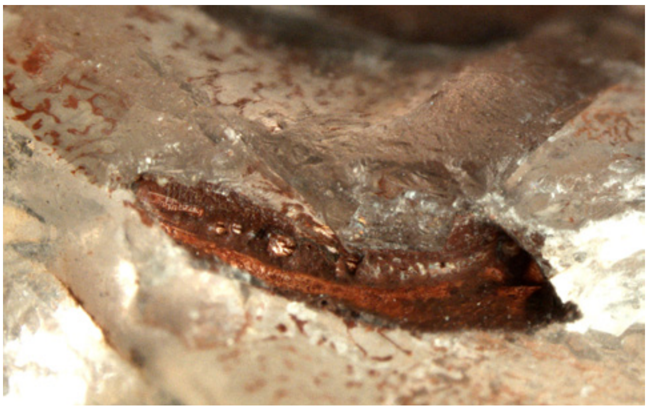

Figure 14 – This brown material could be seen to fill low areas and depressions in the Oregon feldspar much in the same way the residues did in the Tibet material. Sometimes there were even spherical voids present that looked like gas bubbles. Photomicrograph by S. F. McClure. Field of view 1.5mm

Figure 15 – On a couple of occasions areas of the Oregon matrix had a coppery metallic sheen. Chemical analysis of these areas showed a Cu concentration up to about 700 ppmw. Photomicrograph by S. F. McClure. Field of view 2.1mm

ABOUT THE AUTHOR

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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.