Observations on Identification of Treated Feldspar

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Introduction

The diffusion treatment of at least part of the plagioclase series of feldspar has been successfully duplicated in the laboratory. Labradorite and andesine feldspar from four different localities have been diffused with copper, turning pale yellow material to red and green and inducing copper inclusions within the stones (figure 1). The exact method and conditions of this treatment are important, but of far greater significance is the development of criteria and methodology to separate these treated stones from their untreated counterparts. This article offers some observations on this situation as it stands today.

Figure 1. Experiments have shown that andesine and labradorite feldspar can be diffused with copper to turn light yellow material red, green or bicolored. Photos by Don Mengason.

China

The material that started this controversy is a red feldspar that was first claimed to be andesine from the Congo. While there is no direct proof refuting the existence of the alleged mine in the Congo, this claim has become very doubtful. Several individuals have been to mines in Mongolia and brought back evidence that they clearly exist. These mines only produce yellow material, apparently, but in quantities of many tons per year. It now appears that these Mongolian mines produce most, if not all, of the andesine feldspar originally claimed to be from other sources, including the Congo.

The first thing one notices about the Mongolian feldspar is that the color is never homogeneous. It is usually heavily zoned, in combinations of red, green, yellow and colorless. There are, however, several consistent features of this zoning.

In stones that are red and green, the red zones are usually on the outside, surrounding the green zone in the center (figure 2)—contrary to some reports, this is not always true. When yellow or colorless zones are present, they usually cut through the red and green zones (figure 3). By "cut through," we mean the colorless zones follow along twin planes and dislocations that are very common in feldspar. These structural defects become decorated with native copper, which appears to draw the copper out of the structure of the surrounding feldspar, in effect removing the color.

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This has not yet proven to be the actual mechanism, but it is similar to what happens in corundum, where the natural formation of rutile (TiO_2) via exsolution can rob the titanium from the structure of the sapphire, creating a colorless zone around the rutile needle. The “decolorized” zones in the feldspar can take on many forms, from columnar colorless zones that look like round or ovoid colorless “holes” through the red zones when viewed in the right direction (figure 4), to irregular tracks or trails (figure 5) to large zones that are more colorless than red (figure 6).

Figure 2. Diffused feldspar may show an area of red color surrounding a green zone. Photo by Don Mengason.

Figure 3. Yellow or colorless zones can often be seen “cutting through” red and green zones. Photo by Don Mengason.

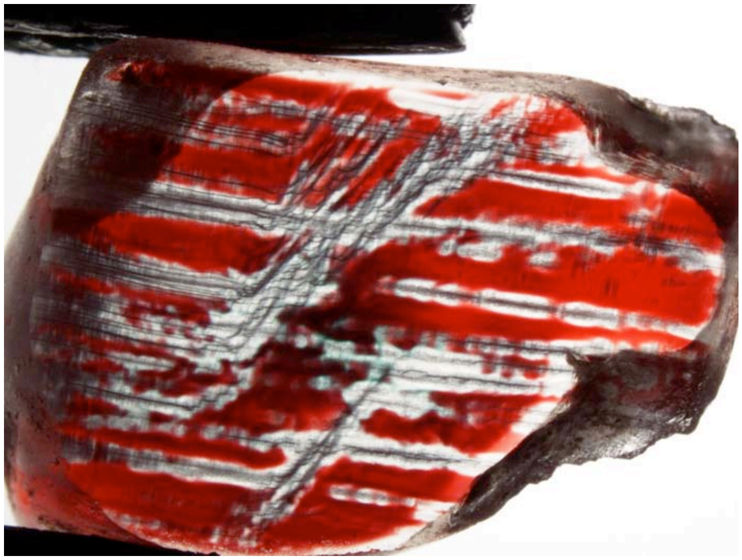

Figure 4. Colorless “holes” through red zones that follow dislocations can sometimes be seen in the treated material. Photomicrograph by Shane McClure.

Figure 5. Irregular colorless tracks through the red or green zones are common. Photo by Don Mengason.

Figure 6. Sometimes there are so many dislocations that the colorless zones are larger that the red or green zones. Photo by Don Mengason.

This brings us to the discussion of inclusions in this Mongolian material. Solid mineral inclusions in feldspar are uncommon and usually not very distinctive. The most prominent features seen in these stones are separations that follow twinning and dislocations (figure 7) and clouds of minute reflective particles (figure 8). Both of these are white in untreated yellow samples but are typically colored by native copper in the treated material. The dislocations often create interesting formations that can resemble wires bent in many different directions (figure 9) or strings of clouds that follow intricate patterns (figure 10).

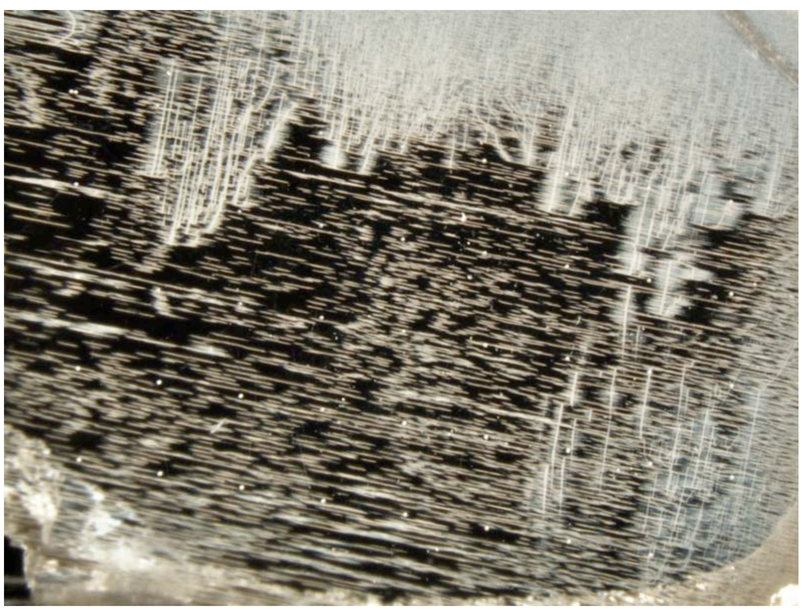

Figure 7. The most prominent inclusions in Mongolian feldspar are separations that follow twinning and dislocations, as seen in this untreated yellow stone. Photomicrograph by Shane McClure.

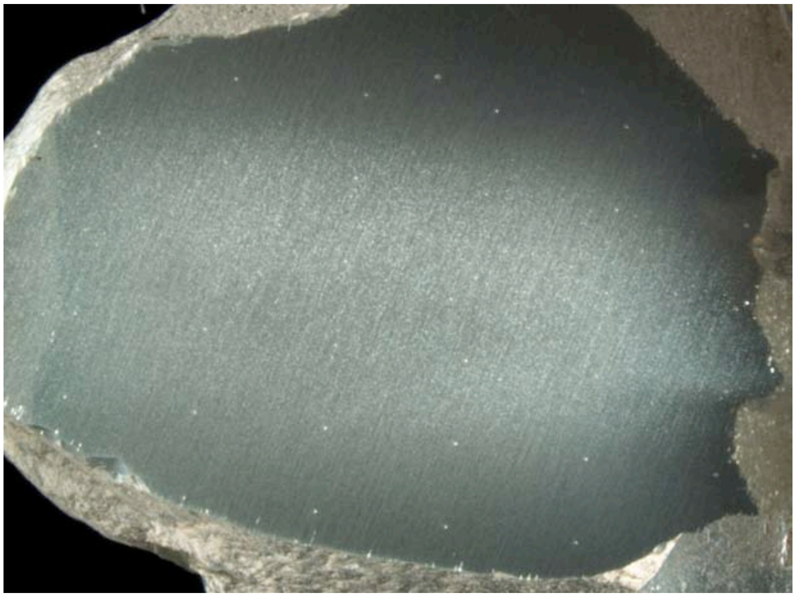

Figure 8. Reflective clouds are also quite common in Mongolian feldspar, as seen in this untreated sample. Photomicrograph by Shane McClure.

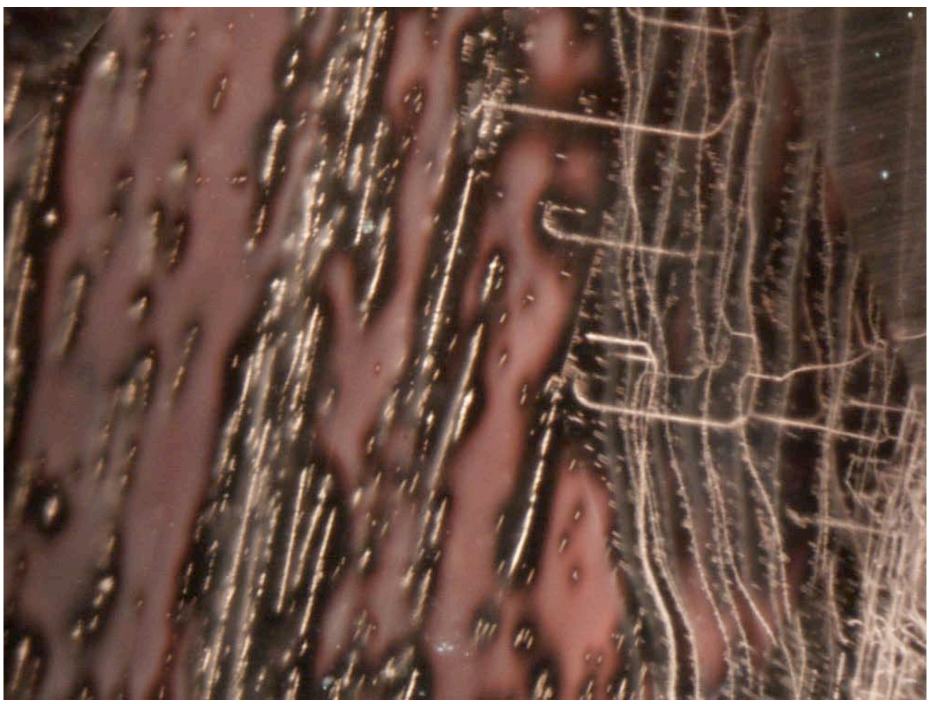

Figure 9. Dislocations can sometimes resemble wires bent in many different directions. Photomicrograph by Shane McClure.

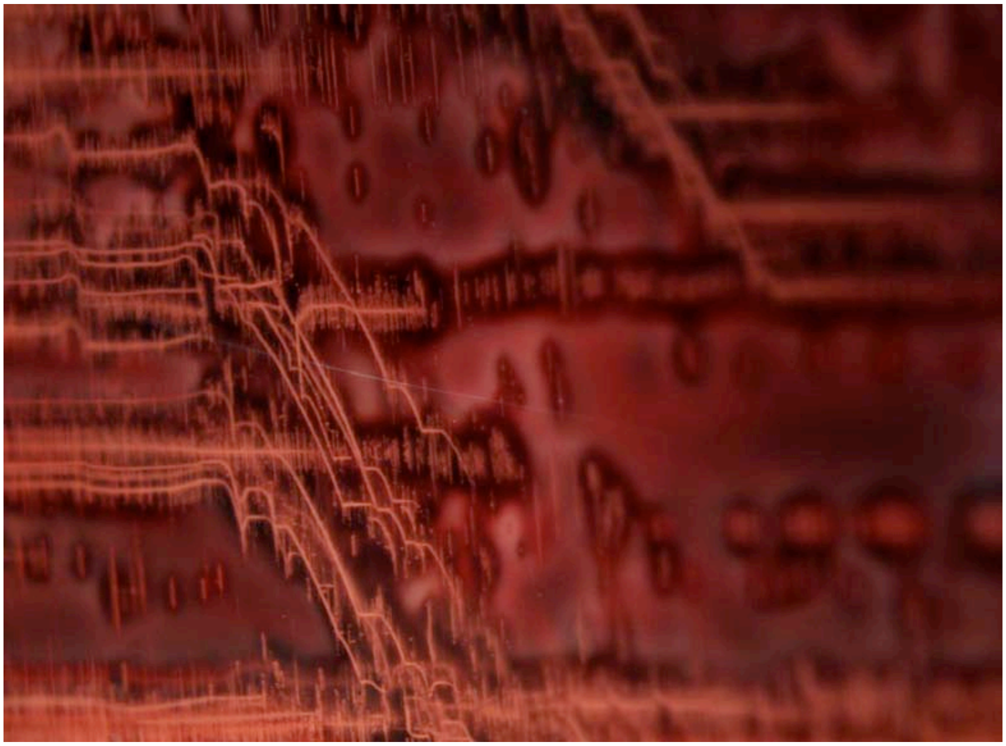

Figure 10. Intricately patterned strings and clouds are also common inclusions. Photomicrograph by Shane McClure.

Another interesting phenomenon displayed by this Mongolian feldspar is its tendency to scatter light off the copper nanoparticles that are responsible for the red and green color. If the stone is held next to a strong light source, the light will be scattered and give the appearance of a translucent reddish cloud with a well-defined pattern. The colorless and yellow areas show no scattering at all. The red areas show strong scattering, and the green areas show the strongest of all (figure 11). This feature is not visible in transmitted light, but is easily seen in oblique or strong top lighting, such as a tensor light or a fiber-optic light. This phenomenon is often confused with color change, in that a green stone may appear red in certain kinds of light (figure 12). The difference is that the colors are not dependent on the color temperature of the light (incandescent vs. daylight) but rather on the strength of the light source and the viewing angle.

Figure 11. The photo on the left shows a treated red and green feldspar in transmitted light. When the same stone is viewed from the side with a fiber-optic light, the readily visible scattering corresponds directly to the color zones. Photomicrographs by Shane McClure.

Figure 12. The effect of scattering in some green feldspars is often confused with color change, as the light reflected from the copper nanoparticles makes the stone appear red. Photos by Don Mengason.

If Chinese gem feldspar were limited to Mongolia, detecting treated material from this region would be simple. Only yellow material comes from Mongolia, so by default any red or green Chinese feldspar would have to have been treated. However, there is evidence that a mine in Tibet produces red and sometimes green material. This mine site has been visited by a noted gemologist/geologist, Dr. Ahmadjan Abduriyim, and he is convinced it is real. This author has seen the evidence and must admit it is compelling. There is undoubtedly a location in Tibet that is being worked and contains red feldspar in a secondary deposit. But is this mine real or a very elaborate hoax? Any reasonable person, seeing only the evidence from the mine, would conclude the site must be real. The problem lies in the fact that the red feldspar collected at the Tibetan mine is indistinguishable from the treated material from Mongolia. It is identical in every meaningful way we have examined so far. Of course, we do not pretend to have tested or conceived every possibility. But to date, we cannot separate these materials.

Oregon

The second pertinent category involves the naturally colored feldspar from the state of Oregon, in the United States. This material is of great importance, because it is the only plagioclase feldspar known for certain to occur naturally in red and green. As with most gem deposits, most of the material recovered from Oregon mines is not the most desired color. More than 90% of it is light yellow (figure 13). The best is red and green or yellow with schiller that gives it an aventurescence. Oregon's feldspar miners have long prided themselves in selling an all-natural product, so the possibility of it being treated is a very serious matter. First, it must be reiterated that Oregon samples can unequivocally be separated from Chinese. By the same token, the abundant yellow feldspar from the Casa Grande area of Mexico is entirely different from both the Oregon material and the Chinese material. The difference lies in its chemical composition, which is easily determined with the right equipment and knowledge. This fact has been previously discussed on this website as well as in other research papers and discussions.

Figure 13. More than 90% of the gem feldspar recovered from Oregon is light yellow. Photo by Shane McClure.

Although the treatment controversy has focused primarily on Chinese goods, our own experiments have shown that Oregon and Mexican material will also accept the treatment. Visually, there are many similarities between all of these feldspars in their treated state; microscopic examination cannot really separate them. However, once a stone has been established as being from Oregon, there are some gemological indications that can help identify treated material.

Color Zoning

Oregon feldspar occurs in red, green, yellow and colorless varieties, just like the treated material. There are, however, some differences. In stones that are red and green, the red is usually in the center with the green on the outside (figure 14). This is not always the case, however. Also, the natural material does not, in our experience, display the solid red areas with colorless “holes” though them that are fairly common in treated material (figure 15).

Figure 14. In untreated Oregon stones that are red and green, the green is *usually* outside of the red zone. Photo by Don Mengason.

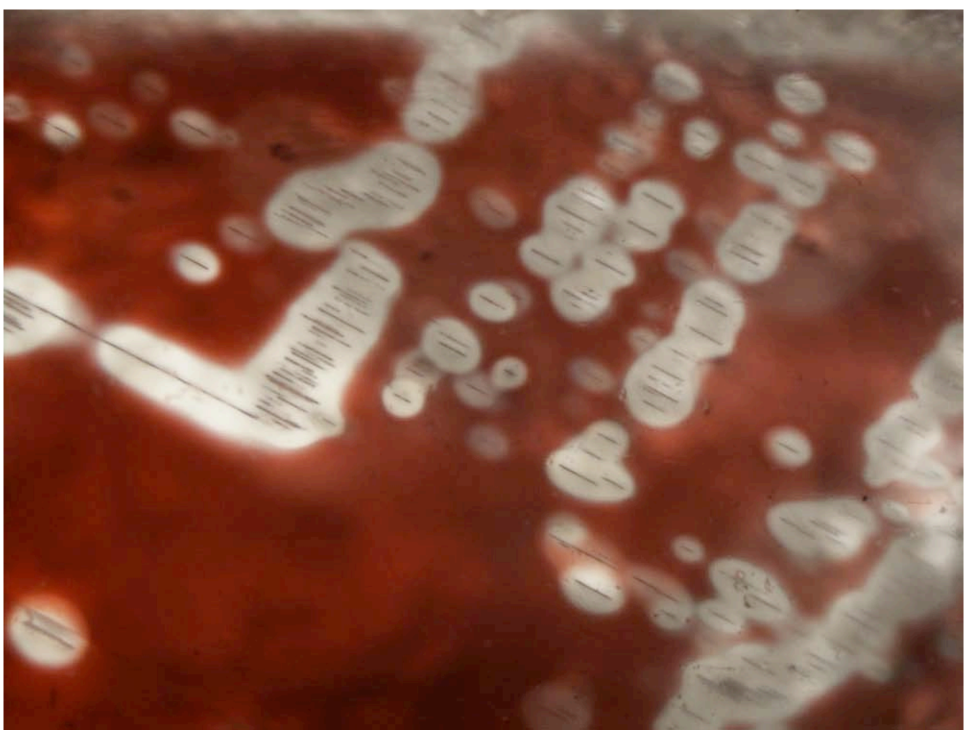

Figure 15. Colorless holes through the red zones, fairly common in treated stones, are not seen in untreated Oregon feldspar. Photomicrograph by Shane McClure.

Inclusions

While many of the internal features of the naturally colored material are similar to those found in the treated material, one very significant difference is the presence of eye-visible schiller in untreated stones (figure 16). This schiller, caused by relatively large copper platelets, is quite common in the untreated Oregon material (figure 17). When schiller is present in treated material, it typically occurs as much smaller particles that are not visible to the unaided eye. If they are visible, they might produce a weak aventurescence that is nowhere near as strong as the effect often seen in the untreated material.

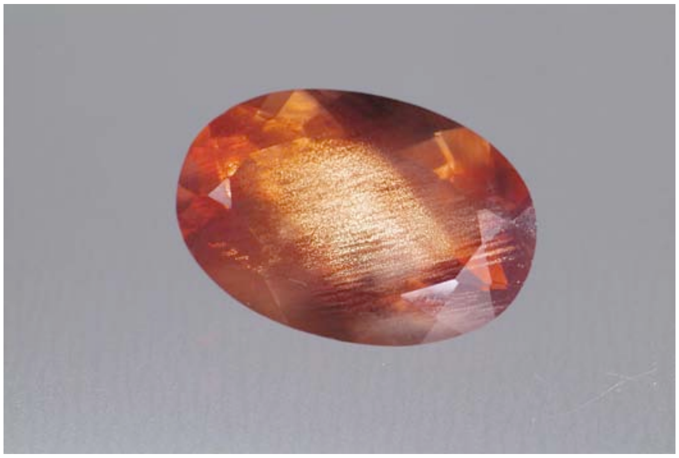

Figure 16. Strong eye-visible schiller is a fairly common trait of untreated Oregon feldspar but is not seen in the treated material. Photo by Don Mengason.

Figure 17. The eye-visible schiller in untreated Oregon feldspar is caused by relatively large copper platelets. Photomicrograph by Shane McClure.

Important indications that require more sophisticated equipment are the distribution and amount of copper content in these stones. Untreated Oregon feldspar follows a consistent pattern related to color, having very little or no copper content in the yellow or colorless areas, higher copper concentrations in the green areas, and higher still in the red areas. The average copper concentrations in the red areas are approximately 100–150 ppm, with a maximum of approximately 200 ppm. In contrast, the treated material we have tested—either samples we acquired from the industry or samples we treated ourselves—seldom has copper concentrations below 300 ppm, and they are typically 400–600 ppm or more. Further, the content in the treated material is fairly homogeneous, meaning the colorless areas have approximately the same copper content as the red and green areas. We have not encountered this relationship in any of the natural material.

Another interesting property of these red and green feldspars is that in the rough, they all have a colorless zone that follows the surface of the stone (figure 18). Curiously, this zone is present in both natural and treated material (figure 19). It exists in every stone—regardless of the locality or who treated it—but in the untreated stones the zone contains little or no copper, and in the treated stones there is significant copper content, as discussed above. The cause of this zone is not yet understood, but could provide some insight into the mechanism that forms these colors, both in nature and in the laboratory.

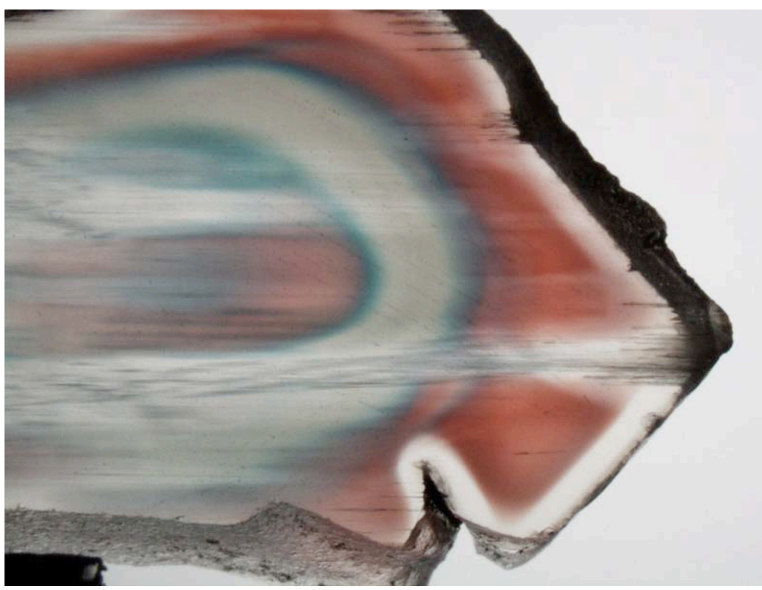

Figure 18. An unusual and still unexplained feature of this rough feldspar is the colorless zone that follows the surface of the stone. Photomicrograph by Shane McClure.

Figure 19. This colorless zone is present in treated (left) and untreated feldspar (right), regardless of the stone's origin or who treated it. Photomicrograph by Shane McClure.

Summary

It has been proven that diffusion of copper into at least some kinds of feldspar is possible. The material that we are now fairly certain comes from Mongolia is treated and can be identified as treated based on the fact that only yellow material comes from that deposit. However, the possibility exists that a Tibetan mine is producing red and green andesine feldspar. If this mine is genuine, we have no way at this time of separating material from that locality from the treated Mongolian material.

Through experimentation we have shown that other feldspars—mostly labradorite—can also be diffused with copper, most notably Oregon and Mexican material. The Oregon material is an issue as it is the only source in the world known to produce naturally red and green material. Most treated Oregon labradorite can be detected based on the nature of the color zoning, some inclusions, and the copper content of the stones.