
INTRODUCTION: We are in the process of bringing a Cameca SX-100 Scanning Electron Microprobe online which simultaneously employs five separate, wave-length dispersive X-Ray spectrometers and a fully automated X/Y translation sample holder/stage. Such an instrument permits rapid acquisition of hundreds of analyses which, after digitization and diverse image enhancement procedures, including contrast-stretching among 256 gray tones, can be displayed as two-dimensional maps of the relative and absolute concentration of the five elements acquired per individual scan. This capability is ideally suited to evaluate the compositional nature of individual schlieren characteristic of impact melts, thereby expanding on previous work that employed select spot-analyses methods. How do individual schlieren relate to the bulk-composition of impact melts? What are their precursors? What can be gleaned about the general process of melt-homogenization during impact?

This work was performed as part of the operational shake-down of our newly acquired SX-100 instrument. Our results are presently limited to relative elemental concentration, yet quantitative analyses are planned. The specimen investigated were holohyaline samples from the Ries and Wabar craters and diverse lunar glasses.

GENERAL OBSERVATIONS: All schlieren that could be observed optically also contrasted chemically with their immediate surroundings; the crispness of individual schlieren were clearly related to the magnitude of chemical contrast. A wide variety of compositional gradients exist, ranging from sharp to highly diffuse contacts between individual schlieren and the melt matrix. Mineral or lithic detritus is readily identified during these scans as well, with the majority of clasts forming exceptionally sharp contacts with the melt-matrix; gradational transitions between clasts and melts are the exception. On rare occasion is the development of a schlieren demonstrably associated with the melting of a clast as first reported by (1, 2, 3, 4). Most schlieren are not monomineralic or monolithic melts, but are substantially mixed, displaying subtle compositional contrast with the melt-matrix at best. Most of these observations were reported earlier, yet the present work permits better generalization.

SPECIFIC SAMPLES: Lunar glasses 60095 and 64455 are largely devoid of schlieren and are very homogeneous, chemically. The most schlieren-rich samples investigated were from the Ries and Wabar craters. Representative scans of the Ries glass (Otting quarry), are illustrated in Figure 1, employing three different spatial resolutions, with analysis spots separated by -18, -5 and -1.6 µm, respectively. The elements selected are consistent with the most prominent component minerals of the granites and gneisses in the Ries basement (1, 2, i.e., quartz [Si], feldspar [Al], and pyroxene [Fe]; additional scanned elements include Ca (plagioclase/pyroxene), K (orthoclase; not shown). Note the sharp contacts of the quartz detritus in the Si elemental maps, and the general paucity of Si-rich schlieren. The upper third of the low-magnification (left column) scan contains a fair amount of feldspar, with the upper right-hand corner reflecting a "granitic" clast composed of quartz, pyroxene and plagioclase. Fe-rich schlieren are prominent and persistent at all scales, and Ca is largely sympathetic with Fe, suggesting enrichment of pyroxene in the most dominant schlieren. The low-magnification Al-scan reveals surprisingly few schlieren enriched in feldspar (as does the K-scan; not shown). The intermediate resolution (middle column) was purposely selected to include an Al-rich region, which is further magnified in the center of high-resolution frames (right column). This area turns out to be a mixture of pyroxene and Feldspar, yet without a substantial quartz-component. While additional details could be offered, the most salient points of the Ries melts are: schlieren are present at all scales and they represent incompletely mixed mineral or lithic melts; pyroxene-enriched schlieren are much more prominent than those of quartz or feldspar. The Wabar melts also contained many schlieren, yet the majority differed only in Fe and Ni from the melt matrix, suggesting that they are the result of finely disseminated projectile materials (4), rather than of incomplete homogenization of target melts. Again, while clastic quartz is common, essentially pure SiO2-schlieren are rare in the Wabar melts.

CONCLUSIONS: The origin of schlieren in impact melts can have a variety of causes, ranging from incomplete mixing of the impactor to incomplete mixing of target components. The latter appears to be the dominant process because compositionally variable targets are the rule (e.g., Ries) and essentially monomineralic targets, such as at Wabar, are rare. The relative frequency of schlieren in Ries glasses that are enriched in quartz, feldspar and pyroxene seem consistent with the relative ease with which these minerals melt under shock-conditions.

Figure 1. Elemental maps for Si, Fe, Al and Ca of a Ries impact-melt obtained on the Cameca SX-100 Scanning Electron Microprobe at three spatial resolutions (Low, Medium and High; left to right, respectively). These images have been contrast enhanced to accentuate the concentration variations of the elements depicted; darker areas indicating low concentrations and white areas indicating higher concentrations of the individual elements.