# APPENDIX Q

# PETROGRAPHIC ANALYSES

# Appendix Q
## Petrographic Analysis of Roof and Floor, 1 North Panel Face

Samples of the roof and floor were collected from the tailgate side of the 1 North Panel face so that petrographic analyses could be conducted. Results of mineral content were plotted on a diagram to assess the incendive potential of the rock encountered by the shearing drums. Underground observations indicated that the tailside drum was cutting sandstone in the roof and floor, while the headside drum was cutting sandstone in the floor.

A sample of rock from the face, directly in contact with the top of the coal seam, had been ejected outward onto the tail drive. The sample contains two rock types, coarse-grained micaceous quartzo-feldspathic siltstone interbedded with medium-grained feldspathic wacke (arkose). The siltstone layers are characterized by gradational laminations in color, highlighted by changes in the relative proportions of biotite and quartz + feldspar. Alternating bands of brown coloration are due to the proportion of biotite in bands that are less than 1 mm thick. Angular, commonly jagged grains of quartz (7% content, 0.03-0.2 mm diameter) are sporadically distributed throughout the rock, with individual grains commonly isolated by a matrix of biotite and muscovite lathes (Figure Q-1). Less commonly, quartz grains touch along tangential boundaries. Quartz grains also commonly touch plagioclase grains along tangential boundaries. Angular, jagged-edged grains of plagioclase (25% content, 0.04-0.2 mm diameter) touch along tangential boundaries and commonly show moderate to heavy sericite alteration. Thin, ragged flakes of biotite (15% content, 0.04-0.2 mm diameter) are abundantly distributed, with individual flakes isolated or concentrated in clusters between quartz and plagioclase. Flakes are oriented parallel and their abundance defines color banding in alternating layers (Figure Q-2). Biotite flakes are compacted around angular corners of quartz and plagioclase grains. Rarely, some flakes are completely altered to chlorite. Thin lathes and ragged flakes of muscovite (5% lathe content, 48% content including matrix sericite, 0.01-0.1 mm diameter) are sporadically distributed with individual lathes or flakes abundantly intermixed with quartz and plagioclase. Fine-grained flakes represent a matrix that generally surrounds individual grains of quartz and plagioclase and occupies angular interstices. In other layers, individual lathes are isolated between angular grains of sericitized plagioclase.

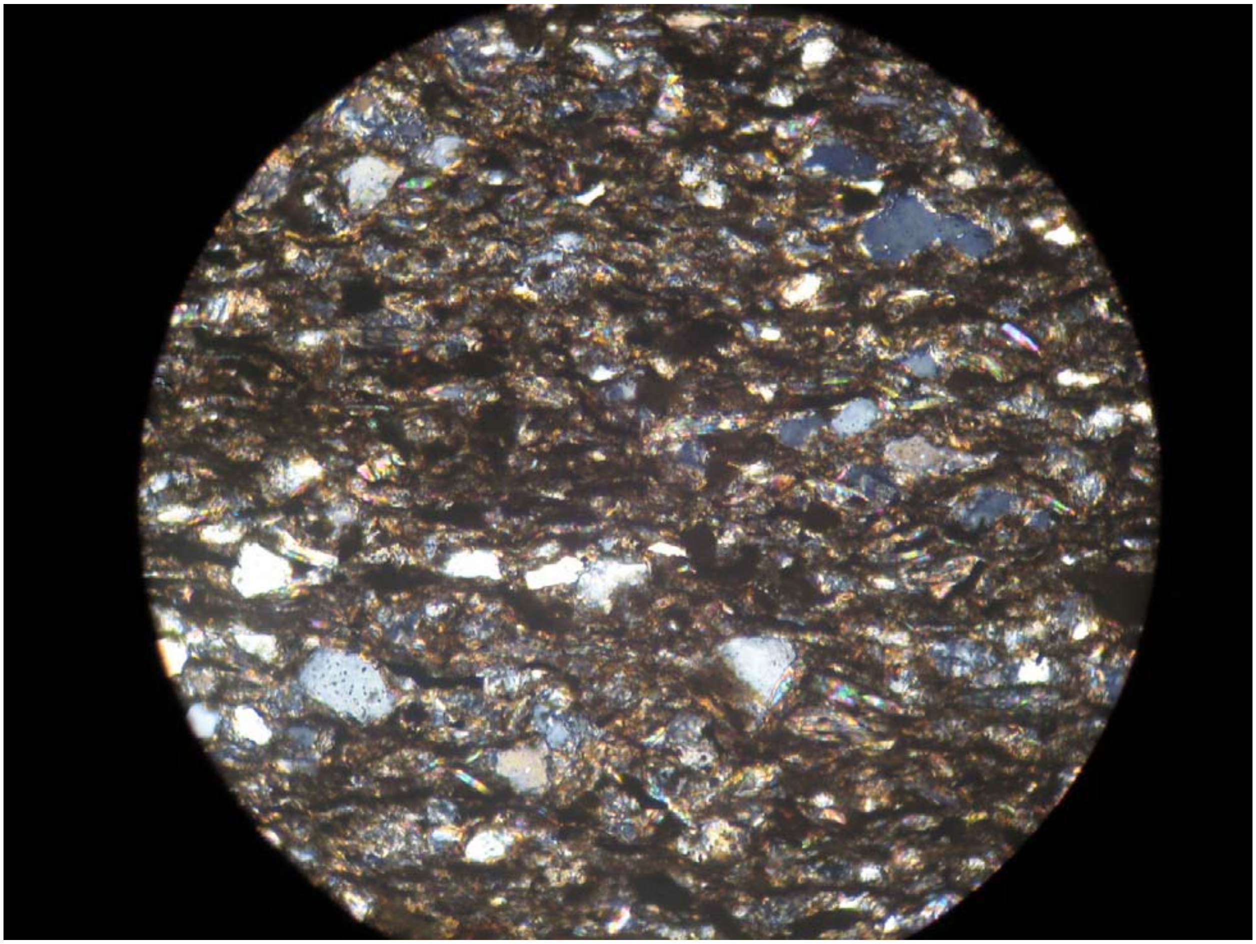

Figure Q-1. Angular grains of quartz (white, yellow) and plagioclase (gray, with dusty sericite alteration) are generally surrounded by a matrix of biotite (dark brown), muscovite (brightly speckled), and illite or very fine-grained muscovite in this sample of coarse siltstone from the 1 North Panel face roof. Field of view 1 mm at 100X.

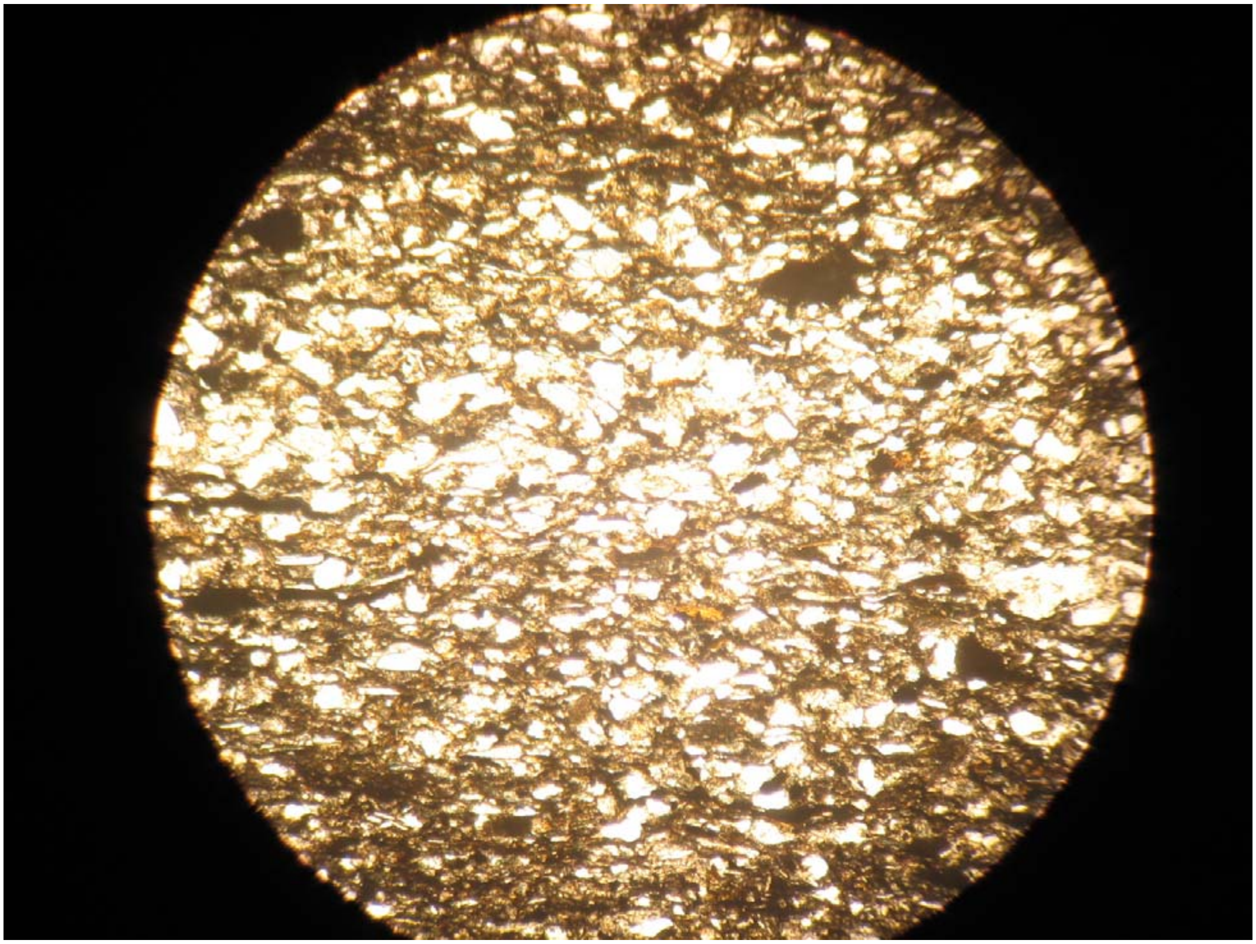

Figure Q-2. The roof rock, viewed in plane polarized light, reveals how changes in the concentration of biotite mica impart the effect of color banding in the coarse siltstone collected from the 1 North Panel face roof. Field of view 1 mm at 100X.

The sandstone, characterized as feldspathic arenite/wacke or arkose, is comprised of angular grains of quartz, plagioclase, and minor microcline that touch along tangential or concavo-convex boundaries, with individual grains or clusters of grains surrounded by a matrix of illite or very fine-grained muscovite (Figure Q-3). Angular, commonly jagged grains of quartz, ranging in size from 0.07-0.6 mm in diameter and constituting 43% of the rock, touch along tangential or concavo-convex boundaries. Angular grains of plagioclase, ranging in size from 0.07-0.4 mm in diameter and constituting 34% of the rock, touch along tangential and concavo-convex boundaries, and are commonly intermixed between larger quartz grains, and exhibit light to moderate sericite alteration. Angular grains of microcline, ranging in size from 0.2-0.3 mm in diameter and constituting 6% of the rock, are sparsely distributed, surrounded by angular grains of quartz and plagioclase. Ragged lathes of muscovite (5% lathe content, 17% including sericite, 0.04-1.1 mm diameter) are sporadically distributed, with individual lathes isolated by surrounding quartz and feldspars (Figure Q-4).

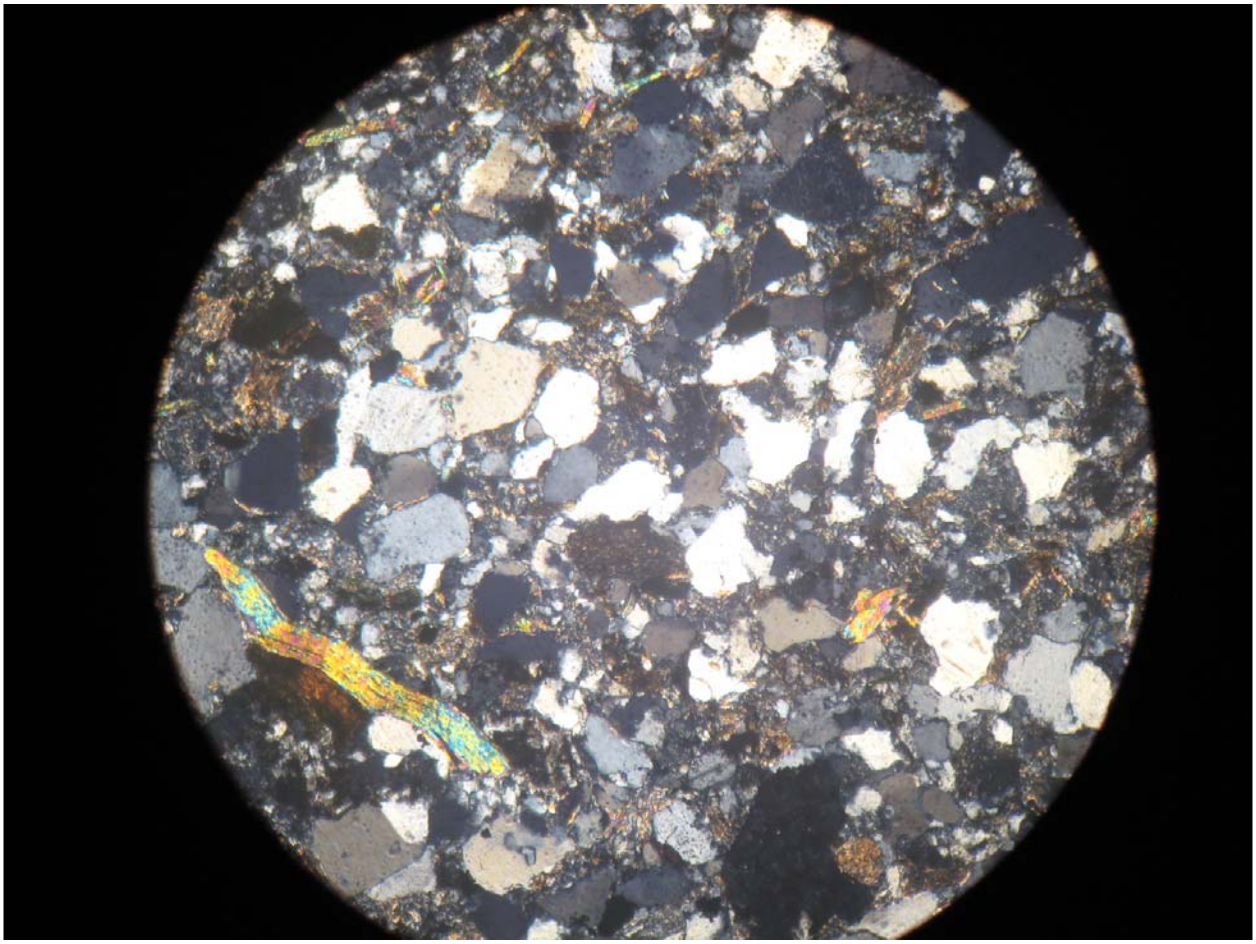

Figure Q-3. Layer of feldspathic arenite interbedded with coarse siltstone from the roof of 1 North Panel face is characterized by angular grains of quartz (white), plagioclase (gray, with dusty sericite alteration), and rare microcline (plaid black and gray) that touch along tangential and concavo-convex boundaries that leave few interstices for illite/muscovite matrix material. Field of view 2.4 mm at 40X.

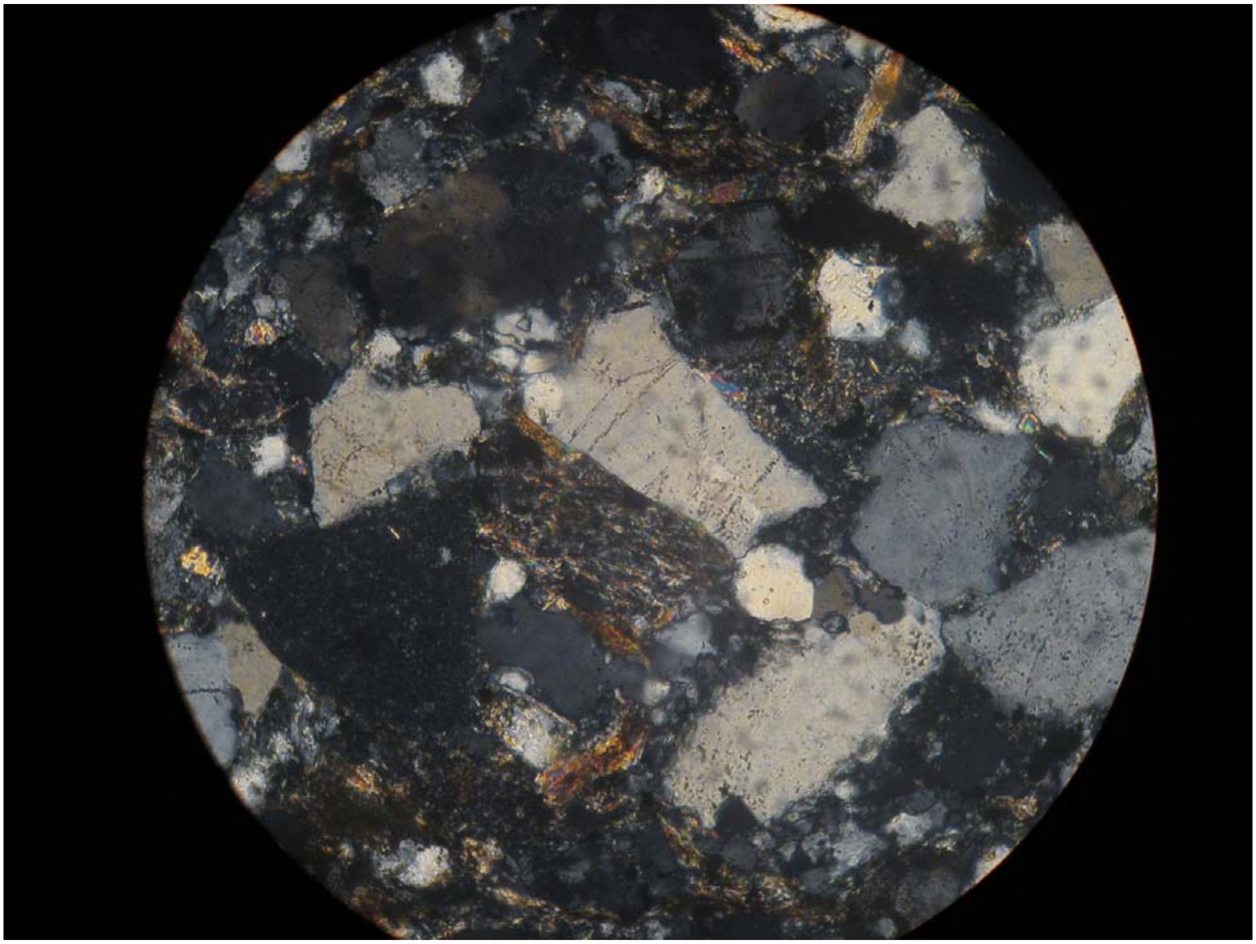

Figure Q-4. Angular grains of quartz (white, shadowed) and plagioclase (gray, with dusty sericite alteration) touch along straight, tangential, and concavo-convex boundaries that leave few interstices for illite/muscovite matrix. Field of view 1 mm at 100X.

A sample of the floor (LWTG ss22582) was collected for petrographic study from the 1 North Panel tailgate entry, from a layer of heaved up sandstone 36 feet outby the longwall face, beneath survey station 22582 (Figure Q-5). Extraction of sandstone from the floor heave slab's brow fully exposed the crack and confirmed earlier observations that the fracture was rootless, and did not extend farther than 12 inches into the floor (Figure Q-6). Based on petrographic study, the rock is classified as fine-grained feldspathic arenite/subarkose sandstone. In general, angular grains of quartz, plagioclase, and minor microcline interlock along straight, concavo-convex, and sutured boundaries with small flakes of muscovite sporadically scattered throughout the rock. Small, angular interstices between quartz and plagioclase are filled with sericite, and plagioclase grains commonly exhibit light to moderate sericite alteration. Angular quartz grains, ranging in size from 0.03-0.2 mm in diameter and constituting 74% of the rock, interlock with each other and plagioclase along straight, concavo-convex, and less commonly, sutured boundaries, especially between quartz grains. Small patches of quartz grains exhibit sutured boundaries that meet at 120° angles. In layers with more sericite in larger interstices, grain to grain contacts may become tangential. Interstitial material and open spaces are rare, with mostly grain to grain contacts. Angular plagioclase grains, ranging in size from 0.07-0.1 mm in diameter and constituting 11% of the rock, interlock with surrounding quartz grains along concavo-convex and straight boundaries. Grains are commonly lightly to moderately altered to sericite (Figure Q-7). Less commonly, grains interlock with quartz along complexly intergrown, sutured boundaries. Angular microcline grains, ranging in size from 0.1-0.2 mm in diameter and constituting 2% of the rock, are roughly rectangular and distributed sparsely throughout the rock, with individual grains surrounded by quartz and plagioclase, with which they interlock along straight and concavo-convex boundaries. Flakes of biotite, ranging in size from 0.07-0.2 mm in diameter and constituting 5% of the rock, are sporadically distributed uniformly throughout the rock, with individual flakes isolated by surrounding grains of quartz, plagioclase, and microcline. Areas of locally higher biotite content represent discontinuous mica-rich interbeds within the sandstone matrix. The long axes of flakes are aligned roughly parallel, reflecting indistinct bedding. Some flakes have been extensively altered to chlorite. Flakes of muscovite, ranging in size from 0.01-0.4 mm in diameter and constituting 8% of the rock if illite and "sericite" is included, are sparsely distributed throughout the rock, with individual flakes isolated between surrounding grains of quartz and feldspar. Muscovite flakes represent only 3% of the rock, with interstitial illite or sericite representing 5%. Angular grains of accessory apatite are sparsely distributed throughout the rock, with individual grains isolated by surrounding quartz and feldspars.

Figure Q-5. Sample of sandstone was collected from floor heave brow beneath survey station 22582 in 1 North Panel longwall tailgate, 36 feet outby the face. Brow of heaved sandstone slab reveals rootless crack.

Figure Q-6.  View of exposed floor heave crack looking straight down, with hammer and tape measure for scale.  The crack is rootless and dies out approximately 12 inches into the floor at a layer of shale.

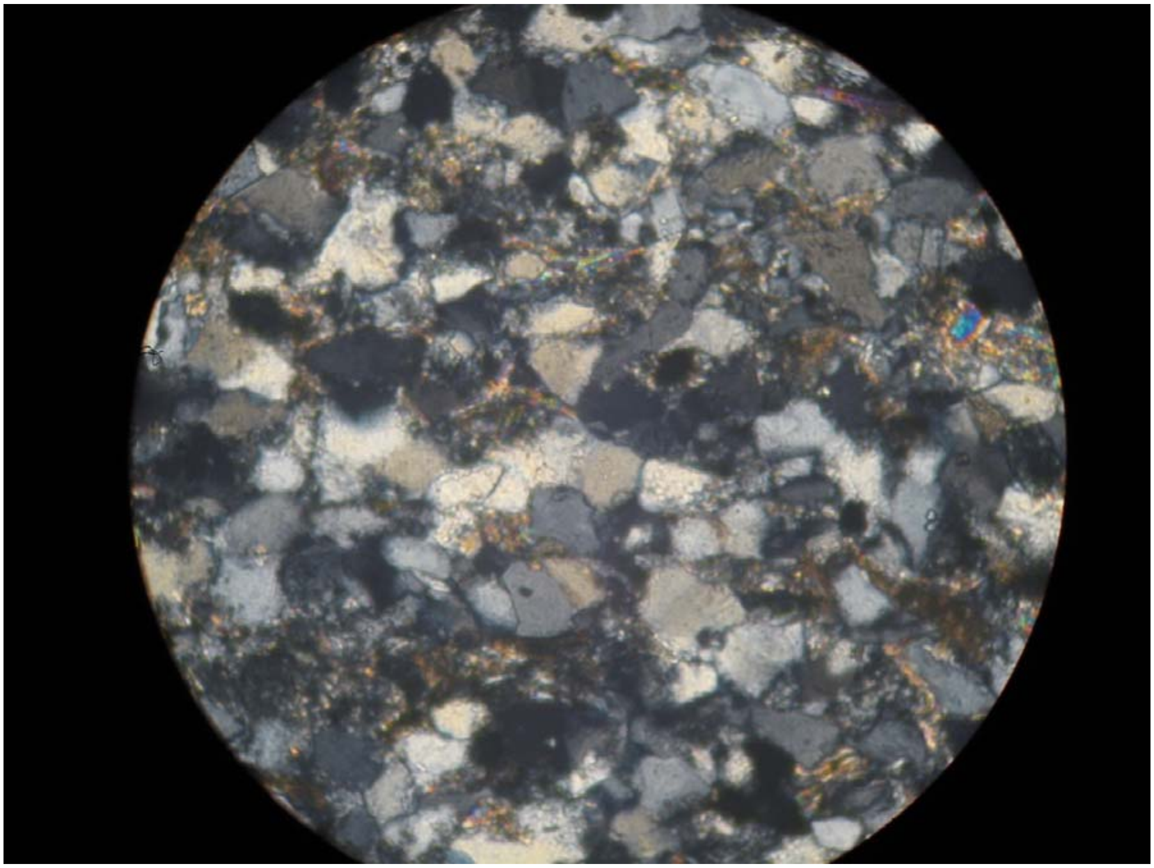

Figure Q-7. In fine-grained feldspathic arenite/subarkose sandstone from floor, angular grains of quartz (yellow, gray) and plagioclase (wavy shades of gray) interlock along straight, concavo-convex, and sutured boundaries, with only minor amounts of mica or sericite in small, rare interstices. Cluster of quartz grains at center of view interlock along sutured boundaries that meet at roughly 120° angles, indicating compaction recrystallization. Field of view 1 mm at 100X.

Compared to the sample collected from the roof, the floor sample contains a much greater quartz content, and is characterized by a much greater degree of grain interlocking, with a significant number of concavo-convex and sutured boundaries. Several areas exhibit sutured boundaries along quartz grains that meet at 120° angles, indicating a degree of diagenetic compaction recrystallization. Similarly, mica flakes are wrapped around obdurate quartz grains due to intense compaction. Due to the higher quartz content in the floor sandstone, it has a higher average Mohs Hardness value of 6.31, compared to a value of 5.83 for the sandstone in the roof, or 3.64 for the dark gray siltstone in the roof. Furthermore, the floor sandstone appears to be more fine-grained, with maximum grains sizes of 0.2 mm compared to grains sizes of 0.4-0.6 mm in the roof sandstone. The grain size distribution also seems more uniform in the floor sandstone.

Based on the mineral contents determined by thin section petrography, the samples were plotted on the ternary diagram developed by Ward et al. (2001) for comparison with the incendivity index developed for rocks in Australian coal mines (Figure Q-8). The layers of coarse siltstone, which contain a high mica content, plot in Category 1, indicating a low potential for frictional ignition. In contrast, the sandstone plots in Category 4, indicating a high potential for frictional ignition. The floor sandstone very nearly plots in the Category 5 zone, due to its high quartz content. It should be noted that the incendivity index applies to rock-on-rock and metal-on-rock ignitions. Thus, sandstone falling in the gob behind the shields, or sandstone being struck by bits on the shearer would both represent potential ignition sources.

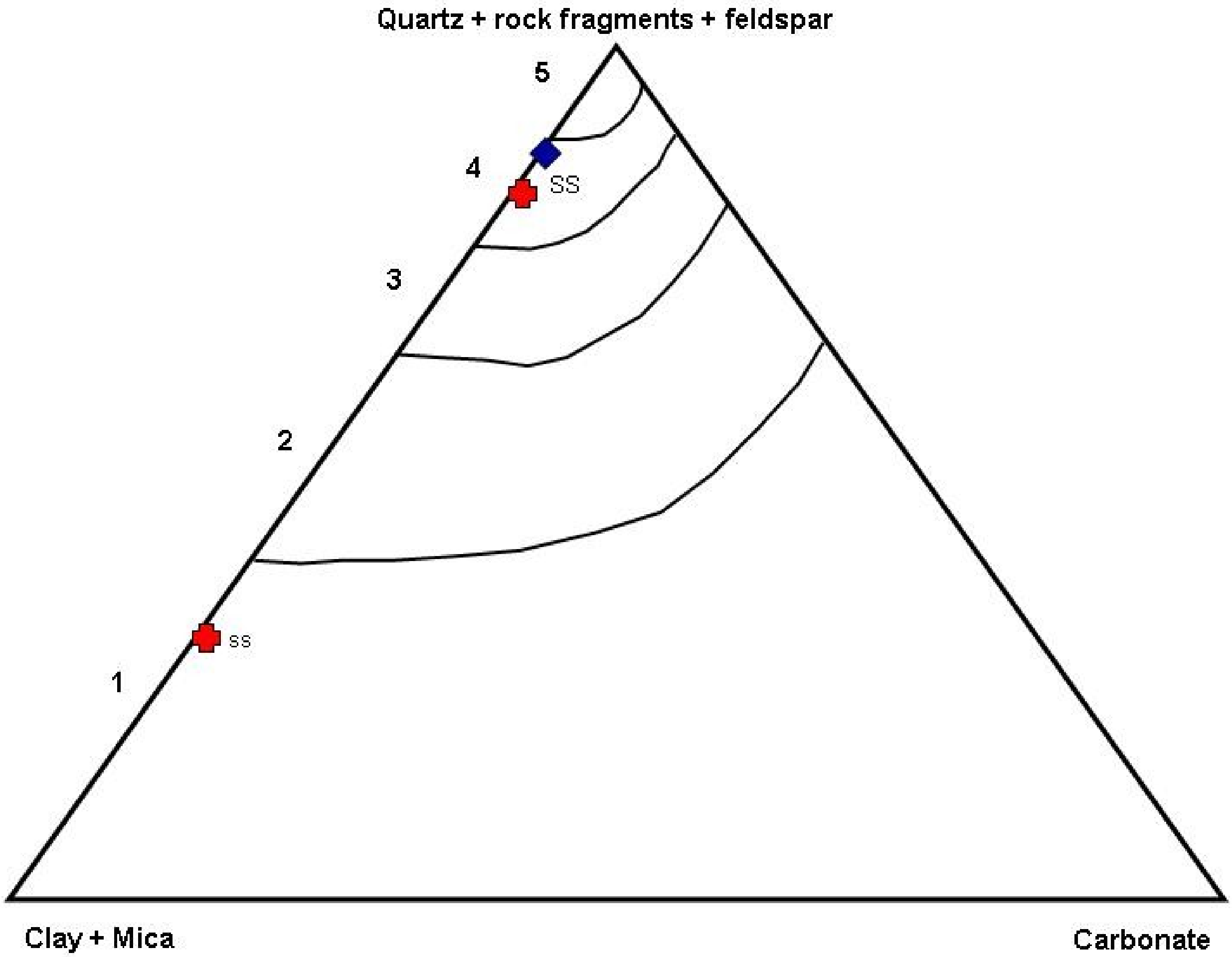


Figure Q-8. Ternary diagram after Ward et al. (2001) showing relation of Upper Big Branch roof (red crosses) and floor (blue diamond) sandstone (SS) and siltstone (ss) to contour lines of incendivity index. Rocks with an incendivity index of 4-5 were shown in tests to have a high potential for frictional ignition. Although sandstone from roof and floor have similar incendivity indices, the floor sample is composed dominantly of quartz.

# APPENDIX R

# WATER SUPPLY SYSTEM TO THE LONGWALL SHEARER DUST SPRAYS