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SIP response for volume content of sulfide mineral in artificial specimen

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Spectral Induced Polarization (SIP) method has recently been introduced to enhance mineral resource exploration techniques in metal ore deposit, South Korea. Because the valuable mineral ore contains various sulfide minerals such as pyrite (FeS), chalcopyrite (CuFeS2), and galena (PbS), which show IP (Induced Polarization) effect. The conventional IP method was not adequate to find these various sulfide minerals because of certain restrictions, including limited frequency. In order to solve this problem, the SIP (Spectral Induced Polarization) method was introduced, which measures responses like as amplitude (or resistivity) and phase for a wide frequency band. The application of the SIP method has been increasing as an exploration technology for mineral resources, because it can be used to acquire and analyze high quality IP data according to the spectral frequency. SIP responses are strong in the presence of the sulfide minerals; however, sufficient study on the characteristics of the SIP response for the various sulfide minerals is not available so far. In this study, in order to identify the SIP response characteristics of sulfide minerals, the SIP method was used in the laboratory; on artificial specimens filled with glass beads and sulfide minerals. The experiment was controlled by the changing volume content, and grain size, of three kinds of sulfide minerals (i.e., chalcopyrite, pyrite, and galena). The grain sizes of the sulfide minerals were varied in five steps: under 0.5 mm, 0.5 - 1.0 mm, 1.0 - 2.0 mm, 2.0 - 2.85 mm, and 2.85 - 4.0 mm, while the grain size of the glass beads was in the range of 0.75 - 1.0 mm. Variation of the volume content of the sulfide mineral was divided into eight grades. The sulfide minerals occupied 0.5, 1, 2, 3, 5, 7, 10, and 20 percent of the total volume 250 ml specimens. The volume content was converted from the weight using the density of a standard volume of 100 ml for each grain size. The results show that phase response increased with increasing volume content of ore, and that critical frequency got lower with increasing grain size. Critical frequency measurement also showed that, in comparison with chalcopyrite content, pyrite was lower and galena was higher. In addition, we proposed empirical equations for the relationship of volume contents with chargeability, volume contents with phase on critical frequency. Therefore, we expect that quantitative estimation of ore grade and calculation of tonnage, is now possible by conversion of SIP responses to volume content of the sulfide minerals present in samples.