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Controlled changes in grain size and pore characteristics of proxies of alluvial sediments and their impact on the hydraulic conductivity and spectral induced polarization response

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Understanding the influence of pore space characteristics on the hydraulic conductivity and spectral induced polarization (SIP) response is critical for establishing relationships between the electrical and hydrological properties of surficial sedimentary deposits. Here, we present the results of laboratory SIP measurements on saturated quartz samples with granulometric characteristics ranging from fine sand to fine gravel. We alter the pore characteristics using three principal methods: (i) variation of the grain sizes, (ii) changing the degree of compaction, and (iii) changing the level of sorting. We then examine how these changes affect the SIP response, the hydraulic conductivity and specific surface area of the sand samples. It was shown that controlling factors like specific surface area or pore size provides good results when predicting hydraulic conductivity of comparable sample types, but the interdependencies remain not sufficiently understood in order to allow for a more wide-ranging correlation of electric and hydraulic properties. In general, the results indicate a clear connection between the applied changes in pore characteristics and the SIP response. In particular, we observe a systematic correlation between the hydraulic conductivity and the relaxation time of the Cole-Cole model describing the observed SIP effect for the whole range of considered grain sizes. The results do, however, also indicate that the detailed nature of these relations depends strongly on variations on the pore characteristics, such as for example the degree of compaction. The results of this study underline the complexity of the origin of the SIP signal and, as a consequence, the difficulty to relate it to a single structural factor of a studied sample.