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A geostatistical approach to estimate mining efficiency indicators with flexible meshes

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Geostatistics is a branch of statistics developed originally to predict probability distributions of ore grades for mining operations by considering the attributes of a geological formation at unknown locations as a set of correlated random variables. Mining exploitations typically aim to maintain acceptable mineral laws to produce commercial products based upon demand. In this context, we present a new geostatistical methodology to estimate strategic efficiency maps that incorporate hydraulic test data, the evolution of concentrations with time obtained from chemical analysis (packer tests and production wells) as well as hydraulic head variations. The methodology is applied to a salt basin in South America. The exploitation is based on the extraction of brines through vertical and horizontal wells. Thereafter, brines are precipitated in evaporation ponds to obtain target potassium and magnesium salts of economic interest. Lithium carbonate is obtained as a byproduct of the production of potassium chloride. Aside from providing an assemble of traditional geostatistical methods, the strength of this study falls with the new methodology developed, which focus on finding the best sites to exploit the brines while maintaining efficiency criteria. Thus, some strategic indicator efficiency maps have been developed under the specific criteria imposed by exploitation standards to incorporate new extraction wells in new areas that would allow maintain or improve production. Results show that the uncertainty quantification of the efficiency plays a dominant role and that the use flexible meshes, which properly describe the curvilinear features associated with vertical stratification, provides a more consistent estimation of the geological processes. Moreover, we demonstrate that the vertical correlation structure at the given salt basin is essentially linked to variations in the formation thickness, which calls for flexible meshes and non-stationarity stochastic processes.