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Assessing and reducing stratigraphic uncertainty in the subsurface: where are we standing?

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Sedimentary strata are essential archives of the past conditions of the earth, and host significant natural resources in the subsurface. However, inferring the features of strata at depth (e.g., geometry, connectivity, physical or geological properties), remains a challenge prone to many uncertainties. Classically, the layers and their geometry are first interpreted from boreholes, geological outcrops and geophysical images, then layer properties can be addressed with geostatistical techniques and inverse methods. Theoretical models considering horizon depth uncertainty have been proposed decades ago, and geostatistical simulation can sample petrophysical uncertainties, but these approaches leave the number of layers fixed and are rely on conformable layering assumptions which are seldom met. We review some recent developments in well correlation in the frame of relative chronostratigraphy, which addresses the problem of locating potential gaps in the stratigraphic record. We also present some first results of the integration of the number of layers in inverse problems using a reversible jump Monte Carlo method. These two elements open interesting perspectives to jointly address topological, geometrical and petrophysical uncertainties at multiple scales in sedimentary basins. Although such uncertainties can have significant impact on quantitative geological and geophysical model forecasts, many computational challenges still lie ahead to appropriately sample uncertainties. Harnessing these challenges should open the way to finding, on a case-by-case basis, the suitable level of detail between detailed stratigraphic architectures and effective medium representations.