

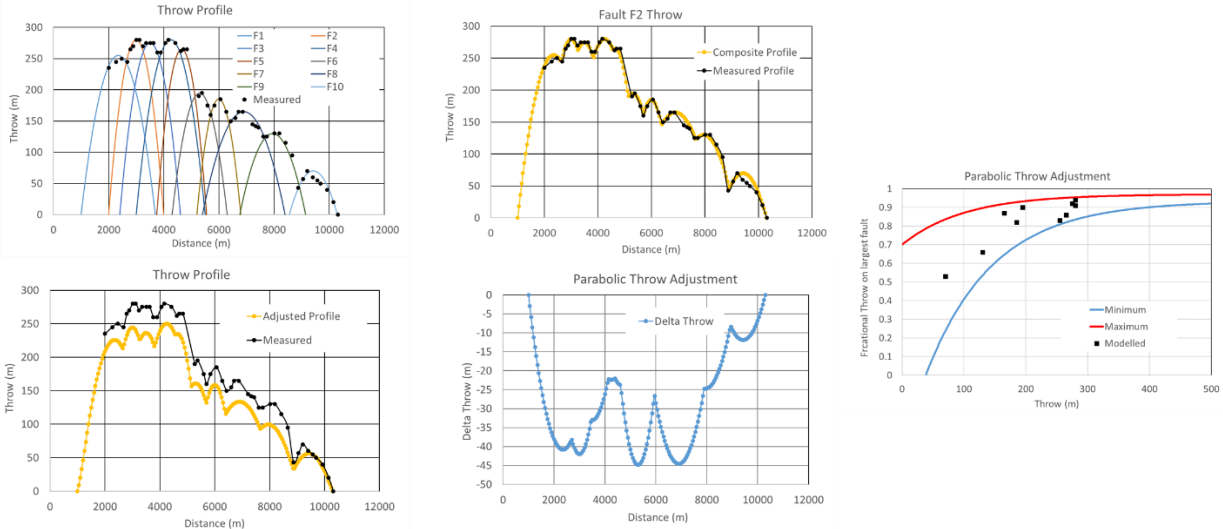
Stochastic Fault Zone Analysis: Modelling Variable Throw patterns using Nested Parabolas

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Abstract

Mapping faults in seismic volumes is a deterministic exercise: it leads to one interpretation of the fault and its throw profile. The result can be qualitatively controlled using 3D mapping tools combined with an understanding of fault geometry and expected displacement patterns. Due to the spatial limitations of seismic imaging however, uncertainties remain in the both the fault architecture and mapped fault throw patterns that relate to sub-seismic fault zone complexity. Lower absolute throw may occur relative to the seismically mapped throw due to displacement partitioning within the fault zone, resulting from a combination of relay zone development, fault lenses, internal layer rotations, normal drag, and the presence of multiple, sub-seismic slip planes. Seismically imaged throw tends to be a maximum possible throw (in the absence of horizon miscorrelations). The presence of throw partitioning potentially impacts fault seal calculations by changing juxtapositions the calculated SGR and modelled shale smear patterns, and it can also affect how fluids are modelled to move around and across a fault during production. This uncertainty can be partly addressed by using a newly developed nested parabolic throw model. The technique fits a series of conjoined (or nested) parabolas to the measured throw profile for a horizon. Each parabola effectively represents a component fault segment that has linked together to form the overall mapped fault. The use of mathematically prescribed parabolas enables a throw adjustment to be made that is distributed coherently along the fault. The adjustment is based on an empirical fractional throw model that tries to capture the uncertainty in throw distribution caused by sub-seismic structure as a function of throw magnitude. This is applied stochastically allowing the uncertainty in fault throw to be better represented as a statistical range. The uncertainty in fault throw can then be used to assess its impact on fault seal calculations and potential fault behaviour in reservoir models.



The figure shows an example of the construction of a nested parabolic model for a fault throw profile (using 10 parabolas). The resultant composite profile is modified by a parabolic throw adjustment that uses the stochastic fractional throw model shown on far left. Values are randomly selected between minimum and maximum fractional throw values to generate the adjustment.