

Stratigraphic coordinate system

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In certain data processing and interpretation tasks such as spiking deconvolution, tuning analysis, impedance inversion, spectral decomposition, etc., it is assumed that the vertical direction is normal to reflectors, which is not true in the case of dipping layers and may lead to results that contradict their fundamental assumption. To overcome the limitation of these methods in the Cartesian coordinate system or in other words, to validate their assumption, we propose a new coordinate system, in which geometry is more meaningful geologically and follows the natural shape of each reflector. Our algorithm transfers seismic data to a new coordinate system and consists of two steps. First, local slopes of seismic events are estimated by plane-wave destruction method, then structural information is spread along the estimated local slopes and horizons are picked by the predictive-painting algorithm. These picked horizons can be considered as level sets of the first axis of the new coordinate system. Using predictive painting, automatic picking of horizons would use the advantages of both conceptual simplicity and computational efficiency. Next, an upwind finite-difference scheme is used to find the two other axes which are perpendicular to the first axis by solving the relevant gradient equation. After seismic data are transformed into the proposed coordinates, layers will be flattened, and seismic traces will represent direction normal to the reflectors. We call this new system as “stratigraphic coordinates”. The stratigraphic coordinates are designed for depth images, but if applied to time domain images, a scaling factor with dimensions of velocity-squared is needed. Synthetic and real data examples will demonstrate effectiveness of our method.

Keywords: flattening, plane-wave destruction, predictive painting