

Duplex Wave Migration Adds New dimension to 4D Monitoring for SAGD – Athabasca, Alberta

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Duplex Wave Migration (DWM) images vertical features via a second reflection point, the first hit being off of a strong mirror surface. The Duplex wave energy is very small ~2% of the total wave field, but is separated sufficiently by the horizontal orthogonal migration. This new type of pre-stack depth migration is used to directly image near vertical sides, and potential zones within steam chamber. Further, the DWM imaging can selectively illuminate S-R pairs from one side – 180° azimuthal apertures for a clearer image. This eliminates duplicate images from the Left and Right apertures, and confusing superposition of opposing polarities. Results show: 1) A clear front side reflection and a surprising back side reflection. So, energy must pass through the steam chamber, attenuating by steam and evolving methane. 2) Induced velocities in the steam chamber must be much lower 1200m/s to 1600m/s to bend image rays to near horizontal, and then reflected off the backside to re-emerge at the front side, coherently. 3) Comparing the Left and Right illuminations and the Front and Back side reflections – 4 values – allows for a possible steam attenuation signature to be analyzed. 4) DWM response can be scaled by various parametric relations to view pseudo properties, such as, Temperature, viscosity, shale content / permeability and water saturation. The gas attenuation inference could be very useful here. Conclusion: The DWM seismic response has sufficient amplitude fidelity to preserve rock properties, and other potential attributes, some still to be discovered. The improved delineation of the SAGD melt zone boundaries is used to identify over and under developed areas which enables engineers to target on-going steaming efforts more efficiently. This paper will illustrate the results of DWM analysis performed on a real SAGD operation with a 4D survey conducted after 16 months of steaming.