AN INTEGRATED APPROACH TO INTERPRETATION OF BOREHOLE RADAR REFLECTOR ORIENTATION USING TELEVIEWER IMAGE DATA

SUMMARY

By integration of the 2D radargram with orientated images from optical and acoustic televiewers, orientation of the radar reflectors intersected by the borehole can be determined. When transferred to a 3D environment these allow for the correct orientation of the radargram for intersected radar reflectors making interpretation easier and giving a higher certainty to the resultant reflector interpretations.

PROBLEM

The output from a downhole radar survey is a depth based composite image where omni directional reflection information is flattened into a single plane of no specified orientation. This 2D image can be complex once all the radar reflectors are represented and making sense of the radargram takes some experience in order to get the most out of the acquired data.

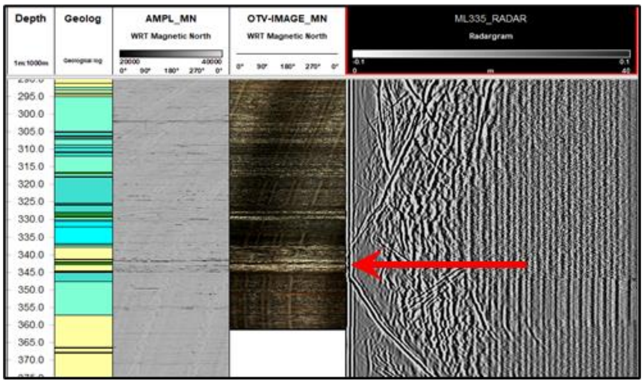
A challenge faced by an interpreter is attempting to assign viable orientations to the radar reflectors present in the radargram. For the most part this has been accomplished by using other priori information like known geological dip and dip azimuth (where reflectors correlate with geology). But what of circumstances where these priori data sets prove unsuitable in defining the radar reflector orientation? Or the reflectors do not correlate with known geology, like faults / shears with unknown orientation?

SOLUTION

What is required is a robust workflow that will give the interpreter ability to separate out individual reflection events in the radargram, correlate these individual events against other orientated data sets captured downhole and assign high confidence orientations. Optical and acoustic televiewers give us just such data.

In this example, a suite of downhole tools was run in a target borehole that included Acoustic Televiewer (ATV), Optical Televiewer (OTV) and Borehole Radar (BHR). In most cases only one or the other of the televiewer data sets will be available and will be dependent on the casing depth, water level and water turbidity at the time of logging, as to which of the televiewers was used.

By combining the orientated, ultra high resolution images of the borehole wall captured by televiewers and the unoriented, fine resolution, borehole radar data in a single workflow makes it feasible to interpret the orientation of near hole reflectors out to the limit of the radar penetration.



Dyke intersection (red arrow) indicated in the ATV/OTV images and radargram (342m to 343m).

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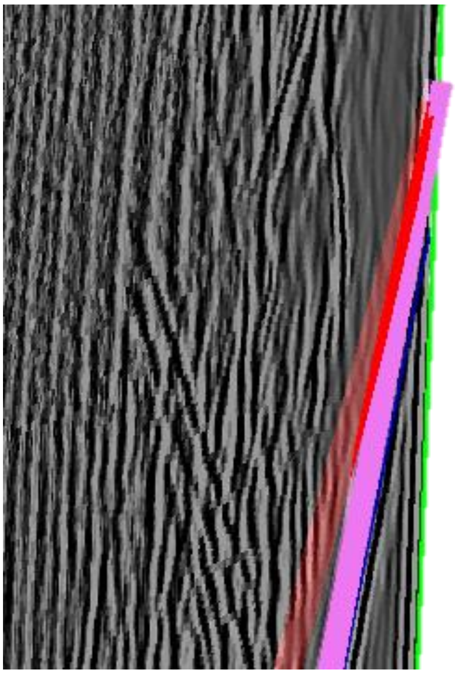
The upper and lower apparent dip and dip azimuths can now be determined from the ATV/OTV orientated images and converted to true dip and dip azimuth for later use as vector inputs in the 3D interpretation to follow.

In this example there is only one major reflector present in the image. In holes with more than one reflector of interest each reflector will need to be interpreted individually both as ATV/OTV correlations and in the 3D processing.

With the initial true dip and dip azimuths determined the data can now be transferred into a 3D environment for further interpretation.

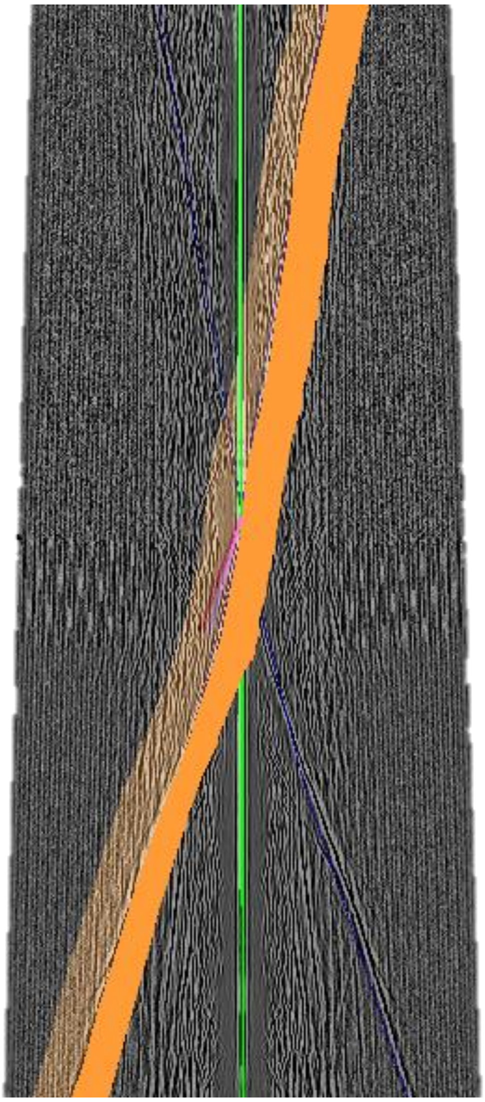
In the 3D environment the borehole trajectory must be established. In this case the acquired gyroscopic deviation survey data was used. The true dip and dip azimuth orientations of the reflector are input as down dip vectors to aid in the alignment of the radargram images in their correct azimuthal orientation.

Radargram images must be imported and attached to the borehole path. Using the down dip vectors the radargram images can be rotated around the BH until the radargram aligns with the down dip vectors.



Down dip vectors created from the ATV/OTV interpreted tadpoles used to align the radargram image in its correct downdip azimuthal orientation.

With the radargrams correctly orientated it is possible to define the radar reflector by selecting points along its length as digitized point coordinates. A surface created from the point coordinates will aid in the visualization of the dyke in 3D space.



Complete up and down dip interpreted dyke intersection presented as a digitized surface.

IMPACT

Integrated processing of the BHR and ATV/OTV orientated image data has significant potential in aiding in the interpretation of intersected radar reflectors. The methodology itself is robust and repeatable resulting in high confidence interpretations to de-risk and aid in mine planning.