HALLIBURTON

FORMATION EVALUATION | PETROPHYSICS

Stoneley wave fracture conductivity analysis

Locate and estimate conductivity of fractures crossing a borehole

FEATURES

The results are:

- Continuous Stoneley-wave reflectivity curve with location of reflection sources
- Estimated fracture conductivity (equivalent fracture width)

The algorithm analyzes the entire waveform data recording, resulting in a more reliable fracture conductivity product.

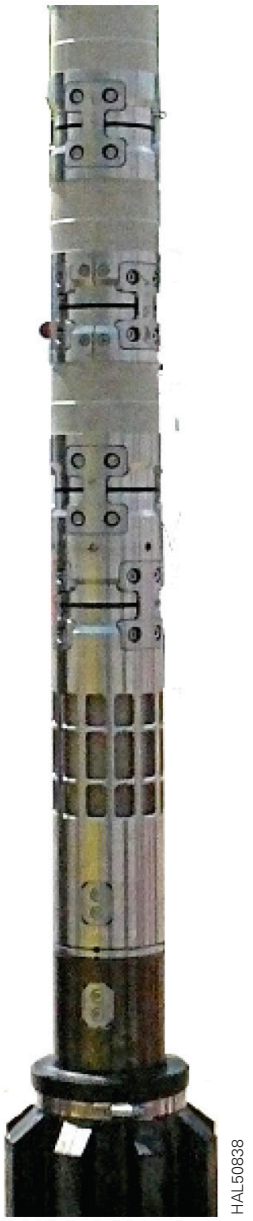
Overview

Sonic waveform analysis of Stoneley-mode arrivals can locate and estimate the conductivity of fractures crossing a borehole. A key feature of the analysis is to discriminate Stoneley responses due solely to conductive fractures by using borehole Stoneley waves recorded by a Xaminer®-level borehole sonic tool.

Borehole Stoneley waves have been shown to be sensitive to conductive fractures crossing a borehole (e.g., Hornby et. al, 1989). For this analysis, the Stoneley wave can, in effect, be considered as a simple pressure pulse propagating along the borehole. When this pressure pulse encounters a conductive fracture, pressure is released into the fracture, and this pressure change creates a secondary source that excites a new, or secondary, Stoneley wave. This secondary Stoneley wave is then received late in time by the long recording time waveforms from the tool's receivers.

Fracture conductivity analysis benefits

The Stoneley wave fracture response depends on the fracture extending some distance into the formation, and so this technique can be considered to be "probing the fractures beyond the borehole." Fractures that are conductive and penetrate deeply into the formation are more likely to be productive. These fractures are also to be avoided during formation-testing pad placement.



The Xaminer Sonic Imager excites the Stoneley mode in the borehole over a wide frequency range (300 Hz – 5 kHz).

The Stoneley wave fracture conductivity analysis complements fracture detection by borehole imaging techniques (e.g., the Halliburton CAST™, XRMI™, and OMRI™ tools), which will give a high-resolution image of the borehole wall and so indicate the presence and geometry of fractures and other features crossing the borehole. For example, in oil-based mud conditions, the OMRI tool may be blind to determining if a fracture is open or sealed; adding the Stoneley fracture analysis resolves this ambiguity. Note that although this waveform signal is commonly referred to in the literature as a "reflected Stoneley wave arrival," in the case of a conductive fracture, it is not, in fact, "reflected," but the result of a pressure pulse that is generated due to pressure release into the fracture.

Associated answer products

The following answer products are associated with Stoneley Wave Fracture Conductivity Analysis:

- Xpert™-series processing – for example, Sand Production and Fracture Strength Analysis, and Fracture Stimulation Zoning Analysis

STONELEY WAVE FRACTURE CONDUCTIVITY ANALYSIS	
Inputs	Low-frequency monopole waveforms
Outputs	Location and identification of fractures that cross the borehole and extend beyond the borehole. Fracture conductivity (equivalent fracture width)

For more information, contact your local Halliburton representative or visit us on the web at www.halliburton.com