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Stress feature interpretation from ICDP drill holes to constrain the orientations of the three principal stresses: Snake River Plain (USA)

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Downhole data from drilled holes provide a unique opportunity to identify wellbore failure and understand physical properties of the deep sediments and rocks. In the framework of the ICDP (International Continental Scientific Drilling Program) we have obtained and analysed a set of geophysical logging data of two deep boreholes (Kimama and Kimberly) in the Snake River Plain in southern Idaho for the ICDP Hot Spot project. The Snake River Plain represents the track of a deep-seated mantle hotspot that has thinned the lithosphere and fuelled the intrusion of up to 10 km of hot basaltic-rhyolitic magma into the lower and middle crust. This area represents the ideal place for geothermal exploration and exploitation. For that a study of the complete state of stress in this region becomes a key point to know and understand the distribution of fractures and failures and how they can influence the permeability of the Hot Spot geothermal reservoir.
Processed acoustic borehole images acquired along two boreholes detect a variety of natural and drilling induced features on the borehole wall, including bedding, fractures and breakouts. Three primary types of stress-induced drillhole indicators, breakouts, petal centre-line fractures and tensile fractures, were analysed in detail in order to define the orientation of the present-day stress state. Borehole breakouts are stress-induced elongations of a borehole cross section and on borehole images they appear as dark features and in some cases, incipient breakouts have been identified by conjugate shear fractures, where no spalling of the borehole wall has occurred. The drilling induced tensile fractures appear as dark electrically conductive features, with a strike parallel to the direction of the far-field greatest horizontal stress. They can be differentiated from natural fractures because they do not cross the borehole, do not form complete sinusoids shape on BHTV images and show a discontinuous nature. On the contrary the natural fractures are often seen as continuous sinusoids and appear as electrically conductive or electrically resistive (open and close fractures respectively). A consistent population of natural fractures has been identified along the boreholes. The dataset of all complete failures was compared with existing stress records of the area to obtain an exhaustive picture of the present-day stress field in the Snake river Plain.