

Direct Imaging of Fracs, Natural Fracture Networks, and Producing Volumes with Passive Seismic Data

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Abstract

This presentation will describe a new surface-based, passive seismic technology that accumulates total trace energy over time periods from minutes to hours to days. The method is used for hydraulic fracture monitoring, direct imaging of producing reservoir volumes, water flood imaging, identification of sweet spots in 3D reflection surveys, and other applications. Images of ambient seismicity (natural background seismicity) are acquired by quiet-time recording during reflection surveys and prior to frac monitoring. Frac monitoring products include: images of hydraulic fractures and natural fractures stimulated by hydraulic fractures as complex surfaces and networks, not dots-in-a-box; direct images of the Stimulated Reservoir Volume; and images of producing volumes after or before stimulation (the latter in fields with producing wells). Standard micro-earthquake hypocenters and focal mechanism solutions are a byproduct of the method. The images can be exported in standard for-mats and imported into hydrofrac and reservoir simulation software to provide more accurate and realistic simulations. A very recent development is inverting the fracture surface images for reservoir stress. The method yields the relative magnitudes and orientations of all three principal stresses and can be calibrated to provide absolute stress values. Stress in-version can be accomplished with ambient images, so that the reservoir stress state can be estimated prior to drilling.