



**M.D. WOOD, INC.**  
A FRACTURE MAPPING SERVICE FOR  
THE ENERGY INDUSTRY

ANALYSIS OF GROUND TILTS  
ASSOCIATED WITH HYDRAULIC  
FRACTURING AND CAVITY FORMATION  
IN SALT, ST. CLAIR, MICHIGAN,  
DECEMBER 12, 1978

for

The Solution Mining Research Institute

by

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## SUMMARY

Ground tilts associated with hydraulic fracturing and the early stages of cavity formation were measured at the site of the Mead Project of the Diamond Crystal Salt Company on December 12, 1978. Although small--averaging between 3.0 and  $5.0 \times 10^{-8}$  radian--the tilts associated with fracturing are clearly documented in analog and digital records. Tilt changes that occurred after the start of injection of unsaturated brine were considerably greater. Ground tilts at the time of communication of the injection and target wells were consistent with tilts expected from a penny-shaped fracture with a radius of 180 feet, the distance between the two wells. The volume of this fracture should have been roughly equivalent to the volume that had been injected by the time of communication, so that there is no evidence of fluid leakage into the formation. The overburden rock appears to have behaved highly elastically during the treatment period. The tilt measurements suggest that the average shear modulus of the overburden is about 500,000 psi.

The overall symmetry of the tilt changes that were measured on the morning of December 12, 1978 suggests that the underground structure that formed may dip slightly to the northwest.

The tilts that occurred after the start of injection of unsaturated brine indicate a small amount of subsidence of the ground surface above the structure