

# DEFORMATIONS AND ROTATIONAL MOTIONS EXTRACTED FROM DOWNHOLE ARRAY RECORDINGS

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Strong-ground motion data recorded at the Delaney Park Geotechnical Array in Anchorage, Alaska during a number of earthquakes including the 2018 **M7.1** Anchorage event and its **M5.8** aftershock were used to extract deformations and rotational motions at different depths and different intensities of motion. Ground motions are measured at the surface and at six levels below the surface (up to 61 m depth) using three-component borehole accelerometers that record motions in the glacial outwash sediments near the surface, the sensitive clays of the bootlegger cove formation, and at its deepest into the glacial till. Only few direct reliable measurements of rotational component of strong-ground motions from earthquakes are obtained so far. In the meantime, high quality earthquake data recorded at downhole arrays provide an opportunity to estimate deformations based on the differences in recordings at various depths. Deformation or simple shear strain with the rate  $\gamma$  is the combination of pure shear strain with the rate  $\gamma/2$  and rotation with the rate  $\alpha = \gamma/2$ . High level of rotational motions, especially tilting may have adverse effects on tall buildings, towers, bridges etc. (Kalkan and Graizer, 2007). High dynamic range, well synchronized and properly oriented instrumentation is necessary for reliable calculation of rotations from downhole array data. Table 1 shows estimates of maximum deformations at different depths at Delaney Park Array, almost certainly pointing to non-linearity occurring at the surface soft soil layers. High amplitude of rotation of 0.60E-03 rad was observed

at the Eureka downhole array during the 2010 **M**6.5 Ferndale earthquake in Northern California. The highest rotation rate of 0.55E-02 rad/s associated with the S-wave was observed at an epicentral distance of 4.3 km during the  $M_L$  4.2 event in Southern California at the La Cienega downhole array (Graizer, 2017).

**Table 1. Max Deformation at depths at Delaney Park Array.**

<b>Comp. Depth, m</b>	<b>D0-D1 (2.3 m)</b>	<b>D2-D1 (7.6 m)</b>	<b>D3-D2 (14.5 m)</b>	<b>D4-D3 (24.4 m)</b>	<b>D5-D4 (38 m)</b>	<b>D6-D5 (53.2 m)</b>
<b>M7.1</b>	8.70E-03	3.96E-03	2.61E-03	8.67E-04	6.14E-04	3.66E-04
<b>M5.7</b>	2.23E-04	1.16E-04	8.26E-05	6.74E-05	8.76E-05	7.50E-05