INTRODUCTION

The southern Apennines are a NE-verging fold-and-thrust belt, which formed from late Oligocene to Pleistocene times in response to deformation processes induced by the convergence between the African and European plates. The post-collisional phase includes the early Pleistocene development of strike-slip faults, responsible of lateral variations and of the segmentation of the belt. The last tectonic phase that affected the belt is related to an extensional regime characterized by NW-SE faults and is still active.

Present-day stress state can be assessed by different techniques, such as borehole-breakouts, local mechanisms solutions, active faults, hydrofracturing, overprint, crustal deformation and differential strain. Our goals are to compare the local versus regional active stress in Irpinia region and to identify active shear zones along a deep well using borehole breakout and differential log data. The selected area is characterized by diffuse low magnitude seismicity, although in historical times it was repeatedly struck by moderate to large earthquakes. On 23rd November 1980 a strong earthquake (M6.9) occurred in this area producing the first unambiguous historical surface faulting ever documented in Italy. The mainshock occurred on a 38 km-long normal fault, 30°-striking and 60°-northwest-dipping, named Irpinia fault. The surface trace of this fault is very close to the depth of 3280m within an interval depth of 1500m.

To characterize the presence of the Irpinia fault and other possible active shear zones and to define the present day stress along the San Gregorio Magni 1 well, we have analyzed in detail borehole breakout and differential geophysical data. Our analysis of induced and natural borehole breakouts shows a direction of minimum horizontal stress (Shmin). At the nearby plantations Sgmm (N44°±20°). Although some breakout zones with a different trend from the regional one have been identified, they are related to dip-slip on nearby faults. Compared to the borehole breakouts with the differential logs we have defined two most probable intervals where the Irpinia fault cross the borehole around the depth of 2350 and 3800m. We conclude by considering the more general implications of our data for this area considered one of the regions with the highest probability (25%) of occurrence of an earthquake (M-V5) for the next 10 years.

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The 1980 M6.9 Irpinia Earthquake

The Irpinia-earthquake occurred on November 25, 1980 (Mw=5.9), enucleated at a depth of 10-12 km with a focal mechanism characteristic of NW-SE normal faulting planes. This earthquake consists of three subevents, at the mainshock, at 25-26 and 45s from the mainshock. The Irpinia fault is N30°E-striking, N60°-north-dipping with an average horizontal slip of 0.56m along the fault with a total vertical throw of about 30m during the Pleistocene. The first shock (at 0s) is associated both to the Marzano-Carpentia segment and to the Corrado scarpa (1.6 km long) and the second one at 20s on San Gregorio Magni scarpa along a 5km segment. Considering only seismological data, the last event (45s) is supposed to be located on an anti-Apennine N60°-north-dipping in front of the Corrado and Marzano-Carpentia structures, any surface-rupture evidence does not exist for this event.

Borehole Breakout Analysis

Breakouts are used as indicators of the direction of maximum and minimum horizontal stress (Shmax, Shmin, respectively) and they are shear failures of the borehole wall that form when the over compressive stress exceeds the rock strength. The breakout analysis of SGMM1 well was performed by four-arm caliper log from 1200m to 5900m depth. The result shows a cumulative breakout length of 824m with an average Shmin orientation of N18° and a standard deviation of 24° (Figure 3b), with a quality Q.

To understand the scattering of breakout data, a more detailed breakout analysis was performed for each lithological and tectonic zone (Figure 4). With the purpose of identifying the Irpinia fault, a comparison between stress field along the well and the regional stress orientation has been done. Any deviation from the regional value has been considered as a local rotation of stress field if the breakout orientation deviates from the regional one more than 17° and is more than 3°-east of or west of the regional stress. We observe the following depth intervals that separate breakouts with different breakout orientations (Figure 3a) from 2300m to 2500m (zone 1), 3200m to 3450m (zone 2), 4050m to 4250m (zone 3), and 5300m to 5450m (zone 4). Three of these anomalous zones (zone 1, 2 and 3) are located around the area where the Irpinia fault is supposed to cross the well, but it is found that the closer the point on the well is to the zone, the better the quality of the data. The Irpinia fault has a dip between 50°-70°, corresponding to a depth approximately between 2500m to 3000m (Figure 3).

Acknowledgement

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