Geophysical Imaging of Critical Zone of Edwards/Trinity (TE) Aquifer over the Haby Fault of Balcones Fault Zones, Medina County, Texas, USA

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Geology

The Cretaceous Edwards and Trinity Aquifers of central Texas are critical groundwater resources for human and ecological needs. The karstic aquifers are managed separately by regional water regulatory entities, and they have been historically treated as independent systems, both scientifically and from a water policy standpoint. The Edwards Aquifer region has three subdivisions: Contributing, Recharge and Artesian Zones (**Figs. 1 and 4**). The Recharge Zone is contained within the Balcones Fault Zone [BFZ (**Figs. 3 and 5**)]. The BFZ is a fault system consisting of numerous normal faults with hanging walls generally dropping down toward the Gulf of Mexico with displacements as great as 853 feet (260 m) The Aquifer is underlain by the Trinity Aquifer. The Upper Glen Rose member (Upper Trinity) underlying the Edwards Aquifer has historically been interpreted as a confining unit (**Figs. 2 and 3).** However, recent awareness of a significant connection between the Edwards and Trinity Aquifers has resulted in a number of hydrogeologic investigations documenting that they actually operate as a single system in some locations and under certain circumstances. The Haby fault juxtaposes the Lower Cretaceous Edwards Aquifer units with the younger Upper Cretaceous rocks of the Eagle Ford Formation with a 300 feet throw (95m) **(Fig. 5).** The Edwards Aquifer is presented with the Dolomitic Member on the upthrown side of the fault and is underlain by the Trinity Aquifer.

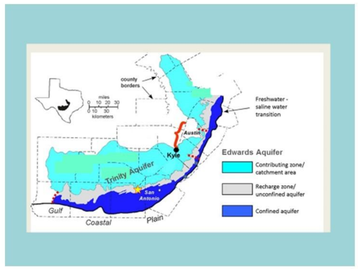

FIG. 1

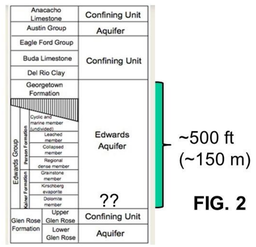

FIG. 2

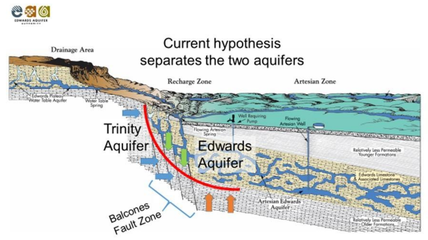

FIG. 3

FIG.4

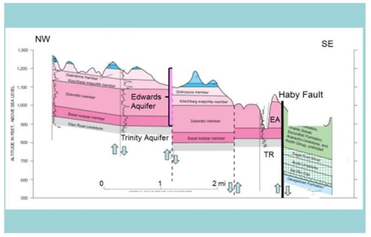

FIG.5

Geophysics- Year 2008

The purpose of the geophysical study was identify the Haby fault, to determine locations of karst anomalies (caves, conduits, and faults/fractures) on either side (up and downthrown) of the fault, and evaluate the fault in terms of its significance on the Glen Rose (Trinity) and Edwards Aquifer unit's interconnectivity (T-E) (Critical Zone!). We first encountered the fault while we performed some integrated geophysical study for a client to assess proper locations for power poles along a transmission line in Medina County, Texas (**Figs. 6 and 7**). Locations of the Haby fault and the first geophysical line (yellow in color), and a karst feature (large void) are shown in **Figure 6.** A 2D resistivity, natural potential (also called self-potential), conductivity (EM31) and magnetic (G-858) surveys were conducted across the fault in the year 2008. Some of the field pictures are shown in **Figure 8.** The resistivity data clearly indicates the location of the Haby fault, and the Eagle Ford Formation and the Edwards Aquifer on the downthrown and upthrown side, respectively. In addition, the resistivity data indicates another fault, which actually was mapped by the USGS as a branch of the Haby fault. The NP data indicates a significant positive anomaly over the known karst feature and a **Fedora-type** NP anomaly across the fault. The source of the NP anomalies are probably due to dissolution along the fault plain. The magnetic data displays a significant positive anomaly over the fault location. This anomaly is well correlated with the Fedora NP anomaly. The conductivity data shows a marked contrast across the Haby fault. Despite all the geophysical results indicating significant anomalies over the fault, the exploration depth of the resistivity data **in Figure 9** did not capture the contact between the Trinity (Glen Rose) and the Edwards Aquifer. It is because of the inefficient length of the resistivity line.

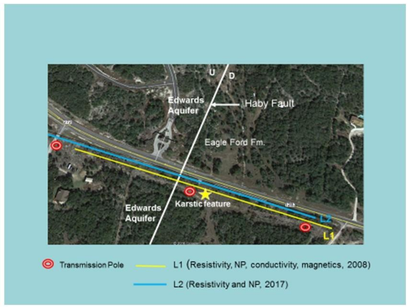

Fig.6

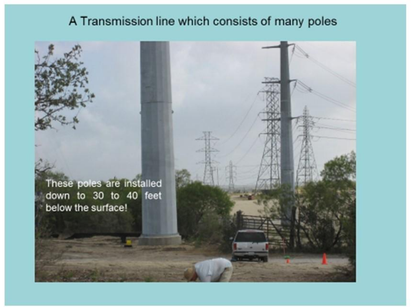

Fig.7

Fig.8

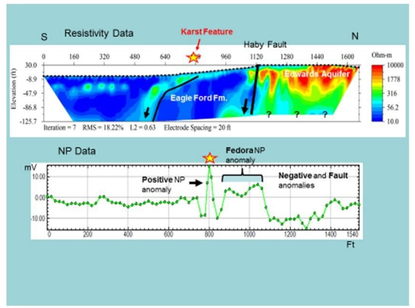

Fig.9

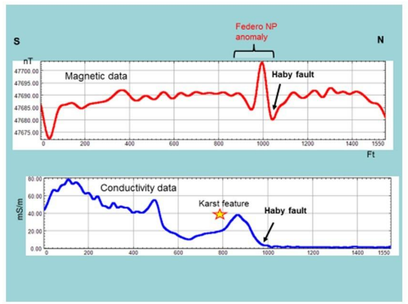

Fig.10

Geophysics-Year 2017

We conducted another resistivity survey with a 10-m electrode spacing using 56 electrodes. This survey line was located about 8m to the east of the first profile L1 (**Fig.11**). The maximum depth exploration was about 122 m (400 ft). The data clearly indicates the location of the fault. The combination of the high and low resistivity values, shown by the red and blue colors on the upthrown section, are the Edwards Aquifer (Dolomitic member). The underlying lithology is the Trinity Aquifer, which is shown by the light blue color. The contact is irregular and it does not appear to be a confining unit for the Edwards Aquifer. The change from high to low resistivity is consistent with the contact of the Edwards and the Glen Rose Limestones. The change is associated with the change in lithology going from a pure limestone to an argillaceous limestone. The location of the Eagle Ford Formation and underlying rocks indicates drag along the fault. Therefore the Edwards units are down-dropped/dragged down the fault along with the overlying upper confining unit. It also shows that the down dropped units are dipping to the south. The low resistivity in the area of the fault is probably caused by fault breccia. The NP data correlates well with the resistivity anomalies (**Fig. 12**).

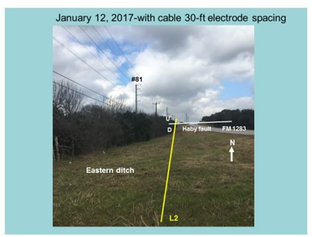

Fig. 11

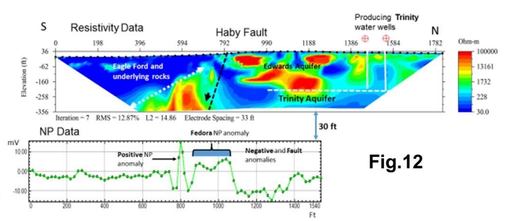

Fig.12

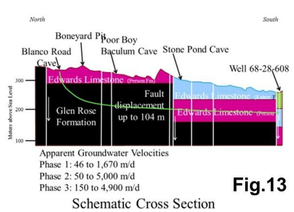

Fig.13

Conclusions

Four geophysical surveys (resistivity, NP, conductivity and magnetics) precisely mapped the location of the Haby fault. The NP and resistivity results indicated karstic anomalies (caves and conduits) in the near vicinity of the fault. The magnetic data displayed a significant high magnetic anomaly where the karstic NP and resistivity anomalies are observed. The cause for the magnetic anomaly may be due to the deposition of magnetic minerals along the fault. The resistivity with the 10-m electrode spacing did map the potential boundary between the Edwards and Trinity Aquifer. This boundary was not a regular confining one; but it was rather interwoven. The depth to the Trinity Aquifer was calibrated from the near vicinity water wells, and its ground water level is shown in **Figure 12**.. This type of boundary may allow for further evaluation of the fault using tracer testing methods and could test the relationship between the Edwards and Trinity aquifers along Balcones Fault Zones (**Fig. 13**).

Acknowledgments

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