October 16, 2001

Richard M. Pollastro
United States Geological Survey, OPS
P.O. Box 25048
Denver Federal Center, MS204A
Denver, Colorado 80225

Dear Rich:

Enclosed is a basemap showing the hand-plotted locations of wells correlated for the Austin Chalk project (requisition reference # 00CR-R01693) and cross-section grid system that we set up to accomplish that correlation (note that the basemap on which information is plotted is from a published set of cross sections for the Tertiary of Texas – some wells are coincident, most are not). Also marked on the map are the locations of 21 well logs enclosed for your reference that represent a strike cross section and several dip sections to give you a feeling for the stratigraphy. Below are some brief comments regarding the procedures we followed and the defining characteristics of the 11 formation boundaries that we correlated.

<u>Procedures</u>
After identifying the 20 or so deepest wells in the 10 counties studied (Brazos, Grimes, Madison, Angelina, Polk, Tyler, San Augustine, Jasper, Sabine, and Newton), we checked the Bureau's log files and those of the Gulf Coast Geological Library, Inc. to obtain the 10 or so best available logs in each county. Their locations were plotted on a basemap and a grid of strike- and dip-oriented cross sections was established. The counties were naturally divided into eastern (Sabine, San Augustine, Angelina, Polk, Tyler, Jasper, and Newton) and western (Brazos, Grimes, and Madison) areas. Strike sections were designated with letters followed by E or W depending on their area (e.g., AE, BE, etc.). Dip-oriented sections were given numbers followed by an E or W, with sections designated 1E6E and 10W13W. The correlations connecting the east and west areas together were made from CE to DW (see blue dashed line on map). We gathered a number of references for the Cretaceous stratigraphy in the area, ranging from summary articles to formation-specific theses. Formation tops were then picked by (1) matching log character from nearby wells in illustrations, where possible; (2) estimating lithology boundaries from descriptions of units in literature where log character was not shown in the literature; (3) comparison with common working definitions annotated on logs by explorationists working in this area; and (4) extrapolation of these correlations into the

other wells on the basis of assumptions regarding the chronostratigraphic nature of defined boundaries. Picks marked on logs from previous investigators were used as a gauge of order-of-magnitude correlation accuracy. In other words, when we saw someone else's marks and they agreed with ours, we were cautiously happy, and when they did not correspond well, we stepped back and took another look. We ultimately agreed with many of these marks, and disregarded a small number of them as not being coincident with tops derived from other data. The spreadsheet of final, resulting, tops was sent August 29 by e-mail.

Tops

Depths have been provided for the tops of the (1) Navarro Fm., (2) Taylor Fm., (3) lower member of the Taylor (base of the Pecan Gap member, which in many places has a character similar to the Austin Chalk and may represent a potentially productive unit downdip), (4) Austin Chalk Group, (5) Eagleford Fm., (6) Woodbine Fm., (7) Buda Fm., (8) Edwards Group, (9) Glen Rose Fm., (10) Sligo Fm., and (11) Hosston Fm.

Both the top of the Navarro and top of the Taylor formations were identified based on correlations illustrated in Stehli and others (1972). In their figure 9, the southernmost well is closest to the intersection of EE and CE sections in our grid. Their surface '0' was taken as the top of the Navarro while their surface 3 was taken to be the top of the Taylor. The top of the Navarro appears to be a flooding surface above a silty interval at the top of the Cretaceous, and is expressed in logs as a relatively abrupt transition from low intermediate resistivity to baseline shale resistivity. The Top of the Taylor appears from Stehli and others (1979) to be a low-resistivity surface more than 100 to several hundred feet below the Top Navarro, and was assumed to represent a maximum flooding surface.

The Taylor is composed of three members, including a shaly interval at the top, the silty to shaly Pecan Gap member in the middle, and a shaly to sandy lower member at the base recording apparent clastic progradation from the northeast. Because the Pecan Gap contains high resistivities and looks similar to the Austin Chalk in many ways, and because the break between the Pecan Gap and the lower member was pronounced, we carried it as a surface in our correlations. If this becomes of interest for assessment, the thickness of the Pecan Gap can be approximated, if necessary, from Top Taylor to Top lower Taylor, the upper Taylor being comparatively thin (tens to 100 ft). The Top lower Taylor was picked where sand or low silty resistivities below transition abruptly to high resistivities. This corresponds approximately to surface 5 of Stehli and others (1979).

The top and base of the Austin Chalk were identified by comparison with figure 2.14 in Montgomery (1995). The log expression of the top is a somewhat abrupt transition from silt below with low intermediate resistivities to a low baseline shale resistivity. The base of the Austin Chalk (top Eagleford/Woodbine/Buda) is marked by an abrupt downward transition from high resistivity to low resistivity of underlying units.

Because the Austin Chalk rests on an unconformity, it is in direct contact with units ranging from the Eagleford to the Buda. This is most pronounced in the eastern area (over the Sabine uplift). If shale was present directly below the Austin Chalk, it was generally assumed to be Eagleford. In some places in the western area, the Woodbine was present also. The top of the Woodbine is generally picked where sandstone transitions upward to the shale of the Eagleford. A thesis by Badachhape (1988) was used extensively for reference on the Eagleford/Woodbine relationship.

The top Buda is a transition from carbonate-dominated rocks below to either clastic rocks of the Eagleford/Woodbine or to the Austin Chalk above, depending upon the amount of section missing at the unconformity. The top Buda was picked on the basis of criteria in Badachhape (1988), and guided by a working definition based on annotations of logs by previous workers. In the downdip area, the Buda is typically clean on the gamma ray and SP, and commonly has high resistivity at the top, especially where the section has been thinned by erosion. Overlying sands or shales can be identified by the low resistivity in sands and the high GR/SP in shales. In the updip area, the base of the Buda is a clean carbonate, and the unit becomes silty and shaly above. In these cases, the top was picked where low intermediate resistivity transitions abruptly upward to low baseline shale resistivity.

This difference in character from updip to downdip is a function of the transition from landward to seaward facies across a carbonate platform to platform margin (Stuart City reef trend) to basin geography prevalent during the lower Cretaceous. It can be seen in the Edwards, Glen Rose, and Sligo as well, and is illustrated well by McFarland (1977).

The top Edwards was picked on the basis of general comments in McFarland and Menes (1991) and McFarlan (1977) as well as picks by previous workers on log copies. In the updip area, the top Edwards is an abrupt transition from high-resistivity shales to the blocky SP character of the basal Buda. In the downdip, the top Edwards is an abrupt transition from clean SP/GR and high resistivity below to a low-resistivity shale at the base of the Buda.

The source of the top Glen Rose, Sligo, and Hosston criteria is similar to that for the Edwards. In terms of log character, the top Glen Rose is an abrupt transition from a shaly low intermediate resistivity to low resistivity Edwards shale in the northeastern area. In the southwestern area, the top Glen Rose is a transition from clean SP/GR to the basal Edwards shale.

The top Sligo is a moderately abrupt transition from moderate to high resistivity and generally shaly SP/GR up to very low resistivity shale at the base of the Sligo. The top Hosston is seen in a limited number of wells and is marked by an upward transition from high to low intermediate resistivities and silty SP/GR to a low resistivity shale at the base of the Sligo.

The citations for the references above are as follows:

Badachhape, Abhaya Ramachandra, 1988, Mid-Cretaceous unconformities in the East Texas Basin and the Sabine Uplift, Master's Thesis, The University of Texas at Austin, 76 p., 13 plates, 19 refs.

McFarlan, E., Jr., 1977, Lower Cretaceous sedimentary facies and sea level changes, U.S. Gulf Coast, *in* Bebout, D. G. and Loucks, R. G., eds., Cretaceous carbonates of Texas & Mexico; applications to subsurface exploration, Report of Investigations -

Texas, University, Bureau of Economic Geology (89), p. 5-11, strat. cols., sects., sketch map, 19 refs.

McFarlan, Edward, Jr., and Menes, L. Silvio, 1991, Lower Cretaceous, *in* Salvador, Amos, ed., The Gulf of Mexico Basin, The Geology of North America, J, p. 181-204, illus. incl. 1 table, sects., geol. sketch maps, 150 refs.

Montgomery, Scott, 1995, Louisiana Austin Chalk, Petroleum Frontiers, 12 (3), 68 p., illus. incl. geol. sketch maps, sects. strat. cols., block diag., 182 refs.

Summary

The Austin Chalk is perhaps the easiest unit for which to identify the top and base in well logs, and those correlations are thus the most reliable. The top Navarro, top Taylor, top lower Taylor, top Sligo, and top Hosston are also reasonably easy to identify, and a moderate to high confidence can be placed on them. The top Woodbine, Buda, and Edwards are somewhat more difficult to pick, especially in the eastern area near the Sabine Uplift, where erosional truncation complicates stratigraphy. These picks should be considered to have moderate confidence. Tops values in the database were checked by hand for accuracy, but misentries may still be possible, as may small correlation busts. Normally, we prepare isopach maps for correlation intervals to look for anomalous values that we would investigate as potential correlation busts or misentries. Unfortunately, the scope of this project and the analog nature of the data precluded such a treatment. If you post the isopachs for each unit and find questionable trends, please don't hesitate to call. I can double-check the values, as well as the correlations, if needed.

If you have any questions about any of these relationships or the correlations, please don't hesitate to call or write. Meanwhile, enjoy the Colorado Autumn and treat your back with tender loving care – in other words, limit the beatings that you subject it to. Best wishes for success in the assessments and for continued good health.

Sincerely,

Paul R. Knox
Research Associate

Enclosures