FLORIDA CARBONATE "FORMATIONS" AND CONFLICTING INTERPRETATIONS OF INJECTION WELL REGULATIONS

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ASTRACT: Florida Underground Injection Control (UIC) regulations define Class I injection wells as those wells that inject fluids beneath the lowermost formation containing, within one quarter mile of the well bore, an Underground Source of Drinking Water (USDW). The USDW is defined as an aquifer or its portion that supplies drinking water for human consumption and contains a total dissolved solids concentration of less than 10,000 milligram per liter. UIC regulations define "formation", in part, as a body of rock characterized by a degree of lithologic homogeneity. In southern Pinellas County, the City of St. Petersburg Class I injection wells inject reclaimed water into the Avon Park Formation. The base of the USDW is located within the Tampa Member of the Arcadia Formation/Suwannee Limestone, which overlie the Avon Park Formation (and Ocala Limestone). Because the Avon Park Formation shares a "degree of lithologic homogeneity" with overlying strata the City injection wells by the UIC's own definition, may not meet the criteria for Class I injection wells.

Carbonate geologic formations in Florida were primarily defined utilizing biostratigraphic data, which contradicts conventions identified within the North American Stratigraphic Code (Code). According to the Code, formations are fundamental lithostratigraphic units that are distinguished and delimited based on lithic characteristics and stratigraphic position. Lithostratigraphic units are independent of inferred geologic history, depositional environment, and fossil content. In contrast, a biostratigraphic unit is a body of rock defined and characterized solely by its fossil content. Because of the similarity of depositional environments, Tertiary age carbonate rock in Florida has been difficult to distinguish by lithologic characteristics alone. Consequently, early workers primarily utilized fossils to distinguish formations. The Tampa Member (formerly the Tampa Formation), Suwannee Limestone, Ocala Limestone (formerly the Ocala Group), Avon Park Formation, Lake City Limestone and Cedar Keys Formation were first identified to varying degrees using biostratigraphic data (fossils). In many areas of west central Florida, contacts between the above formations can not be distinguished unless fossils are present. Lithologically, the contacts can be recognized by coring and thin sections analyses but are rendered indistinguishable when analyzing drill cuttings alone which, unfortunately, is the primary method in which subsurface strata is identified in Florida.

KEY TERMS:formation, Class I injection well, lithology, underground source of drinking water, Underground Injection Control Program.

INTRODUCTIONS

The Florida Department of Environmental Protection Underground Injection Control Program regulates injection wells in Florida and is designed to be consistent with the federal Underground Injection Control (UIC) Program. Injection wells categorized as Class I, III, IV and V are covered by Florida Administrative Code Chapter 62-528. Injection wells defined as Class II are regulated by the Florida Geological Survey. Class I injection wells and governing regulations are the focus of this paper. Wells that inject fluids beneath the lowermost "formation" containing within one quarter mile of the well bore, an underground source of drinking water (USDW) are categorized as Class I. Florida UIC regulations define "formation", as a body of rock characterized by a degree of lithologic homogeneity or similarity, which is prevailingly, but not necessarily, tabular and is mappable on the earth's surface or traceable in the subsurface. Furthermore, a USDW is broadly defined as an aquifer that can supply drinking water for human consumption and contains a total dissolved solids (TDS) concentration of less than 10,000 milligrams per liter (mg/L. In Florida, Class I injection wells are extensively used to dispose of treated municipal wastewater and brine concentrate from reverse osmosis water treatment facilities. In southern Pinellas County, the City of St. Petersburg Class I injection wells (Figure 1) inject reclaimed water into a highly permeable zone of the Avon Park Formation. According to the US Geological Survey (USGS) (Hickey, 1982) the Avon Park Formation is encountered approximately 650 to 800 feet below land surface in Pinellas County.

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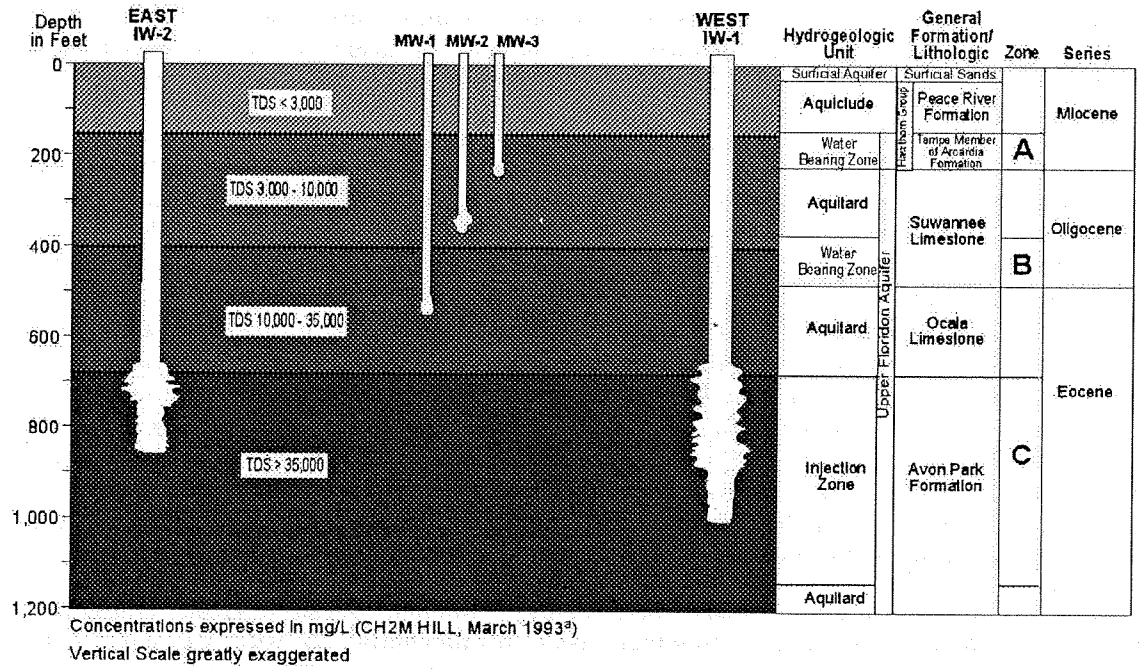

FIGURE 1
Albert Whitted WRF Generalized Pre-Injection (Background Water Quality Profile)

Permeable Zone C, defined by the USGS, is utilized as an injection zone for disposal of excess reclaimed water. Permeable Zone C has been identified in the top portion of the Avon Park Formation and is characterized by fractured secondary porosity with some cavernous porosity. As shown on Figure 1, the base of the USDW is found in the Suwannee Limestone. The Suwannee Limestone overlies the Ocala Limestone, followed by the Avon Park Formation.

Because the Avon Park Formation shares a degree of lithologic homogeneity with the overlying Ocala limestone and Suwannee Limestone, the City of St. Petersburg Class I injection wells may not meet the criteria for Class I status. Recall that the injection zone of a Class I well as defined by the UIC Program must be below the formation that contains the USDW. Because the Avon Park Formation (injection zone) shares a "degree of lithologic homogeneity" with the Suwannee Limestone (base of USDW) they are not truly separate formations and thus Class I status does not apply. The Avon Park Formation, Ocala Limestone, Suwannee Limestone and Tampa Member do share a degree of lithologic homogeneity in that all were originally deposited in a shallow marine environment and are primarily composed of calcium carbonate. To varying degrees each of these rock units have been modified by post-depositional processes and in particular changes to the primary porosity of the rock fabric due to dolomitization, dissolution and fracturing. The latter two have resulted in the formation of numerous highly permeable zones within the strata. However, development of post depositional or secondary porosity can not in itself be used to distinguish lithologic units. If the City of St. Petersburg injection wells do not meet Class I criteria than by default according to Florida UIC regulation they should be considered Class V injection wells.

According to the North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 1983) a formation is a fundamental lithostratigraphic unit that is identified by lithic characteristics and stratigraphic position. In addition, a formation is prevailing but not necessarily tabular and can be mapped at the Earth's surface or traced in the subsurface. Lithologic characteristics include chemical and mineralogical composition, texture, and such supplementary features as color, primary sedimentary structures, fossils (but only when viewed as rock forming particles) or other organic content. Rock type may also be distinguished by electrical, radioactive, seismic, or other properties but these properties by themselves can not be utilized to solely describe the lithic character of the unit. However, a unit distinguishable only by the taxonomy of its fossils is not a lithostratigraphic but a biostratigraphic unit.

Unfortunately, many of the formations present in west central Florida were originally identified and classified on the basis of biostratigraphic data (Miller, 1986). This has been traditionally attributed to the paucity of rock outcrop (surface control) in the Florida Peninsula, the lithologic similarity of subsurface strata (predominantly carbonates) and lack of correlation with north Florida and southern Appalachian clastic sedimentary strata. Pre-

Miocene age strata in Florida predominantly consist of carbonate rocks that have age equivalents with corresponding clastic strata towards the north. For the sake of regional correlation, early workers utilized fossil taxonomy to relate partial sequences of the carbonate platform to age-equivalent clastic rocks to the north (Miller, 1986). This was done in direct violation of standard stratigraphic principles in part because of the lithologic similarity of the subsurface strata.

The stratigraphic column for southern Pinellas County is shown on Figure 1 and is considered somewhat typical of west central Florida. Note that each formation corresponds to a major time classification. For example, the Suwannee Limestone is entirely Oligocene in age while the Ocala Limestone is early Eocene age, and the Avon Park Formation consists of middle Eocene aged rock. The Oldsmar Formation (not shown) underlies the Avon Park Formation and is comprised of lower Eocene age rock. Below the Oldsmar Formation is the Cedar Key Formation, consisting entirely of Paleocene age rock. This obvious relationship between formation and age is a result of using biostratigraphic (time) based data to define each formation. The USGS has struggled with this issue in Florida and has determined that sufficient lithologic differences exist between formations as to warrant keeping the existing classification framework. Revisions to the framework have occurred, however. It was determined that the Lake City Formation (Miller, 1986) was identified through biostratigraphic data and has since been merged into the Oldsmar Formation. Likewise, most workers now classify the Ocala Limestone as a formation-level unit. Previously, some workers had classified the unit at the Group level and divided the unit into three separate formations based upon biostratigraphic data alone.

Some workers (Winston, 1993) suggest that the boundaries between the Suwannee Limestone, Ocala Limestone and Avon Park Formation are simple facies changes rather than major unconformities. Winston also states that the contact between the Suwannee Limestone and the underlying Ocala Limestone is difficult to distinguish in well cuttings because of similar lithology and the absence of fossil fauna. The formation contact can be distinguished, however, when fossils are present. Where the Ocala Limestone is missing, the Avon Park Formation merges directly into the overlying Suwannee Limestone. In other words, the formation contact is indistinguishable on lithology alone.

The gross lithologic similarity of the pre-Miocene age formations has serious implications for field geology in that the major tool of field investigation is the analysis of well cuttings. The identification of formation contacts is extremely difficult using well cuttings due to the lack of depth control and homogenization of the samples. In some cases formation contacts can be distinguished through thin section analysis of rock cores. However, this method of investigation is simply not available to consulting geologists for obvious reasons.

CONCLUSIONS

The City of St. Petersburg Class I injection wells may not meet the criteria for Class I status in that the injection zone (upper Avon Park Formation) shares a degree of lithologic homogeneity with the lowermost "formation" containing the Underground Source of Drinking Water.

If the City of St. Petersburg injection wells are not Class I than by definition they must be considered Class V according to Underground Injection Control regulations.

Pre-Miocene aged "formations" in west central Florida were originally primarily defined using biostratigraphic data because of lithologic similarity, lack of surface exposure, and correlation requirements with clastic rocks in north Florida and southern Appalachians.

The USGS has acknowledged this problem but has noted that sufficient lithologic differences exist to warrant continuing to use existing "formation" names and classification framework.

Formation contacts in west central Florida can be difficult to identify with well cuttings. Thin section analyses of rock cores is somewhat more reliable, however, this methodology is not available to most geologic consultants.

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