INVESTIGATION OF PETROLEUM MIGRATION IN A SAPROLITE UNIT OF THE PIEDMONT IN NORTHERN GEORGIA

AUTHOR: **Michael E. Hermann,** Engineering Science Inc., 57 Executive Park, South, Suite 590, Atlanta, Georgia 30329.
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INTRODUCTION

Accidental petroleum releases from surficial spills or leaking underground storage tanks into saprolite in the Georgia Piedmont require careful investigations in order to determine migration pathways and site specific hydrogeologic parameters necessary for recovery system design. This paper describes the investigation of a particular case in which a shallow water bearing zone within the saprolite was contaminated with gasoline.

The site is located within a belt of low-grade metamorphic rocks associated with the Brevard Zone in Northern Georgia (Figure 1). The surficial soils of the release area were found to be principally clay-rich saprolite, a product of undisturbed weathering of the parent rock.

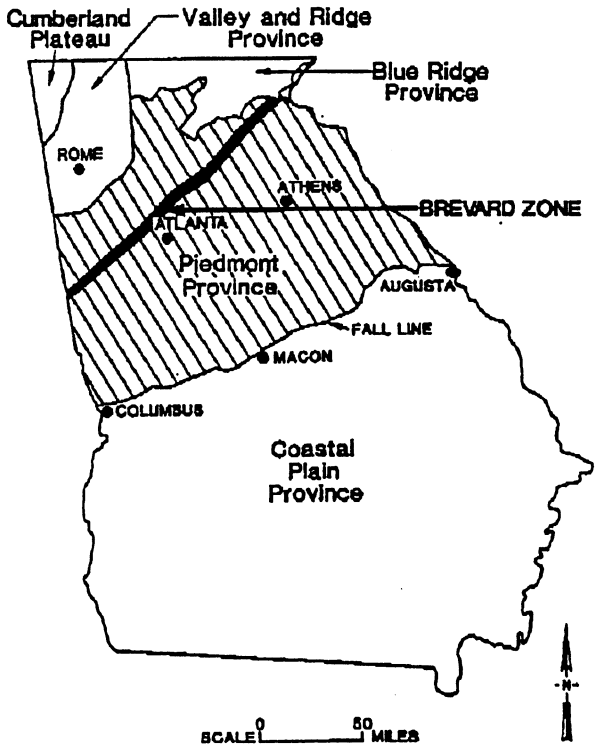

Figure 1. Brevard Zone Location
(Source: Georgia Geological Survey)

METHODS

The subsurface conditions of site were investigated with soil borings and groundwater monitoring wells. The soils were sampled with a split tube sampler through hollow stem augers. The wells were constructed of 2-inch and 4-inch PVC and were installed by hollow stem auger methods. The wells were developed by pumping and/or bailing until the water recovered was relatively sediment free. The well casings were surveyed and water levels were measured with a water-level indicator and converted to elevations. An aquifer pumping test was performed using a 4-inch monitoring well within the source area. Water levels were measured in the pumping well and in several observation wells.

RESULTS

The first groundwater encountered in the upper portion of the saprolite unit was interpreted as being a surficial water-table zone (approximately 30 feet thick), apparently sustained by reduced infiltration through a clay-rich unit located at the base of the upper, more weathered, saprolite. The total saprolite thickness in the area was found to be approximately 90 feet below which rock resistant to augering was encountered. The source of the groundwater was attributed to local surface water infiltration.

Observations of undisturbed soil samples indicated that contaminated groundwater and gasoline were migrating through small fissures and fractures within quartz veins extending through the saprolite matrix.

The groundwater flow direction was interpreted based on water level elevations in area monitoring wells (Figure 2). A relatively steep gradient to the northwest was inferred; however, observation and analysis of water quality from the monitoring wells in the release area indicated that the groundwater petroleum contamination had migrated primarily in a northeasterly direction along an axis perpendicular to the groundwater gradient.

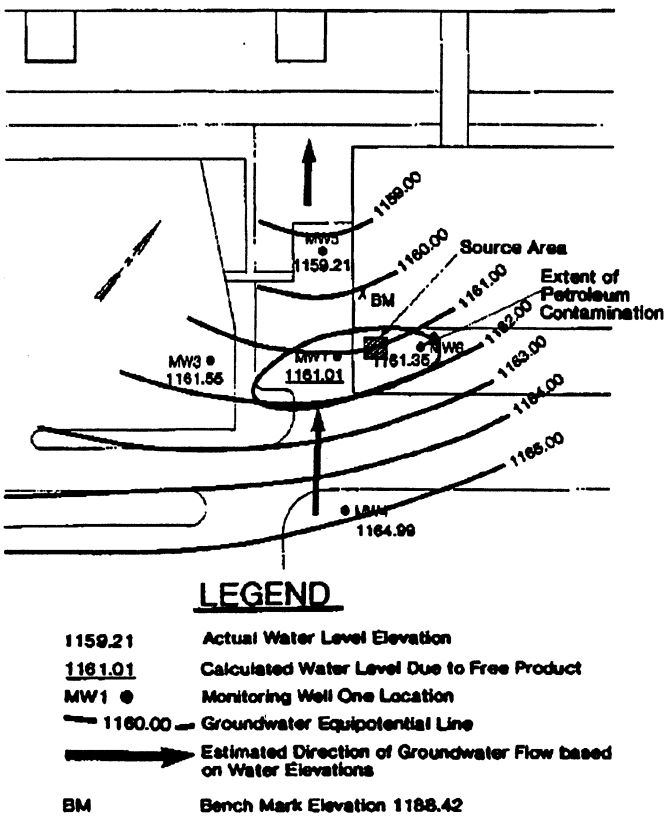

Figure 2. Project Area Location Sketch and Groundwater Contour Map

The hydraulic conductivities derived from the pumping test indicated that the flow directions are anisotropic causing preferential flow in a direction cross-gradient to groundwater flow. The primary direction of anisotropy is approximately oriented in a northeast-southwest direction, and generally oriented along the strike of the Brevard zone. It was concluded that petroleum migration has been controlled by the orientation of quartz veins and remnant foliation planes observed in the soil samples. These features are also generally aligned parallel to the strike of rocks in the Brevard Zone.

Results of the site investigation indicated that in order to recover the observed petroleum contamination, recovery wells had to be oriented along the strike of the deformation zone and in close proximity to the release area. The collection system included a multi-well network used to expedite recovery of the released product and contaminated groundwater from the low-yielding aquifer.