PROVENANCE OF SUSPENDED SEDIMENT DISCHARGED FROM A KARST AQUIFER DETERMINED BY CLAY MINERALOGY

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1. INTRODUCTION

Barton Springs is the fourth largest spring in Texas (Brune, 1981). It is the major discharge point for a segment of the Cretaceous Edwards Limestone karst aquifer. Water from Barton Springs is a significant component of the water resource of Austin, the 21st largest city in the United States. Barton Springs is also a heavily used recreational spot, and it is the sole home of the Barton Springs Salamander (Eurycea sosorum), an endangered species that is extremely vulnerable to changes in water quality (Mahler and Lynch, 1999).

Although in general water quality at Barton Springs is good, there have been occurrences of contamination across the aquifer. Petroleum hydrocarbons, arsenic, lead, pesticides, and other compounds have been identified from aquifer wells (Hauwert and Vickers, 1994). Many of these compounds sorb onto solid surfaces in much higher concentrations than their concentration in water.

After high rainfall (~1") events in the watershed, the water discharged from Barton Springs is noticeably turbid. The purpose of this project was to investigate the mineralogy of the suspended sediment discharged from Barton Springs in order to learn about its provenance and its potential to serve as a vector for contaminant transport through the aquifer.

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2. GEOLOGIC FRAMEWORK AND METHODS OF ANALYSIS

The Barton Springs segment of the Edwards aquifer (referred to here as the Barton Springs aquifer) extends across 391 km² southwest of Austin, Texas, and is composed of eastward-dipping limestones and dolomites of the Upper Cretaceous Edwards and Georgetown Limestones. The aquifer is bounded to the north by the Colorado River, to the west by the limit of the geologic units, to the south by a groundwater divide, and to the east by the "bad-water line, beyond which the water contains more than 1000 mg/l TDS (Slade et al., 1986). Karstification of Edwards lagoonal and rudist reef deposits began during periods of subaerial exposure in the Cretaceous and continued in the Tertiary when formation of the NNE trending Balcones fault zone allowed further infiltration of meteoric waters (Rose, 1972; Maclay and Small, 1984; Slade, 1986). The Edwards Formation conformably overlies the lower Cretaceous Glen Rose Limestone, and is unconformably overlain by the Georgetown Limestone, which in turn is overlain by the relatively impermeable Del Rio Clay and the Buda Limestone.

The Barton Springs aquifer and its watershed are divided into three components (Fig. 1). The contributing zone is that portion of the watershed where the Glen Rose Limestone outcrops. The outcrop of the Edwards and Georgetown Limestones (hereafter referred to as simply the Edwards Limestone), and smaller amounts of Del Rio Clay and Buda Limestone, define the recharge zone. Eastward of the Balcones fault zone and the recharge zone, the Barton Springs aquifer system consists of the porous and permeable Edwards Limestone sandwiched between the relatively impermeable Del Rio Clay and Buda Limestone at the surface and the Glen Rose Limestone at depth. Surface water flows east across the contributing zone via one of six main creeks. As these creeks cross onto the recharge zone, surface water infiltrates through sinkholes and fractures in the streambed providing 85% of the total aquifer recharge (Slade et al., 1986). The direction of groundwater flow is NNE and follows the trend of the Balcones fault zone. Approximately 90% of aquifer flow discharges at Barton Springs in central Austin.

Suspended sediment from Barton Springs (20 samples) was collected during two flood events by in-line centrifugation of large volumes of water. Sediment and rock samples (n=120) were also collected from creeks, sinkholes, caves, soils, and outcrops in the contributing and recharge zones, and from caves, wells, and outcrops in the confined zone (Mahler and Lynch, 1999; Mahler et al., 1999). Whole rock and <2 μm fraction samples were analyzed by X-ray diffraction (XRD). The quantitative mineralogical composition of a representative subset of the samples was determined using the techniques described in Lynch (1997).

3. RESULTS

The suspended sediment discharged from Barton Springs consists of clay minerals (~35%), dolomite (~35%), calcite (~15%) and quartz (~15%) (Fig. 2A) (Mahler and Lynch, 1999). Sediments in karst aquifers can originate both at the surface (allochthonous) and within the aquifer (autochthonous). Figure 2B shows that the same mineral assemblage discharged from Barton Springs does exist autochthonously in the Edwards Limestone. However, with the exception of several marls, Figure 2B also shows that quartz and clay minerals do not occur in abundance in the Edwards. Figure