Coincident Seismic and Ground-Penetrating Radar Images

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Abstract

Among environmental geophysicists, most regard shallow seismic reflection (SSR) as a "deep" imaging technique and ground-penetrating radar (GPR) as a "shallow" one. However, little is known concerning the potential of the two techniques to work together as part of very high resolution surveys in which both methods have been shown to be effective individually. Thus, we present here the results of a series of field experiments illustrating how GPR and high-resolution SSR methods were used to characterize the near-surface hydrology of a site in the Arkansas River valley. These experiments allowed us to examine and compare information obtained by applying SSR and GPR techniques along the same survey lines over a two-year period under varying soil-saturation conditions. Previous work at the site has demonstrated that both techniques work well there.

Because the primary objective of our EMSP research has been to image the near surface at a site in central Kansas using SSR and GPR, we repeated the seismic and radar surveys several times on a seasonal basis to determine how the complementary information acquired varies over time. The combined SSR and GPR data acquired in the upper 3 m at this location may contribute to a better understanding of the relationships between seismic and radar signatures in the near surface.

Data acquired in the field include high-quality seismic *P*-wave reflections obtained from intra-alluvial layers at 0.6 and 1.4 m, as well as one reflection from the top of the saturated zone at a depth of 2.1 m. To detect reflectors at these ultrashallow depths, we spaced the geophones only 5 cm apart. This involved using large numbers of geophones and, as our tests at another site suggest, automating the rapid placement of many geophones at once by means of a mechanical device may be feasible. The GPR data acquired with a 225-MHz antenna showed the two shallower reflectors in greater detail than did the SSR record but did not distinguish the deeper reflector at 2.1 m clearly. The 110-MHz antenna data showed the water table at 2.1 m but failed to delineate the shallower reflectors distinctly. The depth of the water table fluctuates between 2 and 3 m on a seasonal basis at this site, so we were able to monitor variations in the two types of data over a 24-month period.

Imaging technologies such as SSR and GPR may help to establish the spatial extent, direction of flow, and future fate of the chemicals that now contaminate thousands of US sites; thus, further experimentation with such noninvasive methods are likely to be important to the development of effective DOE cleanup strategies.

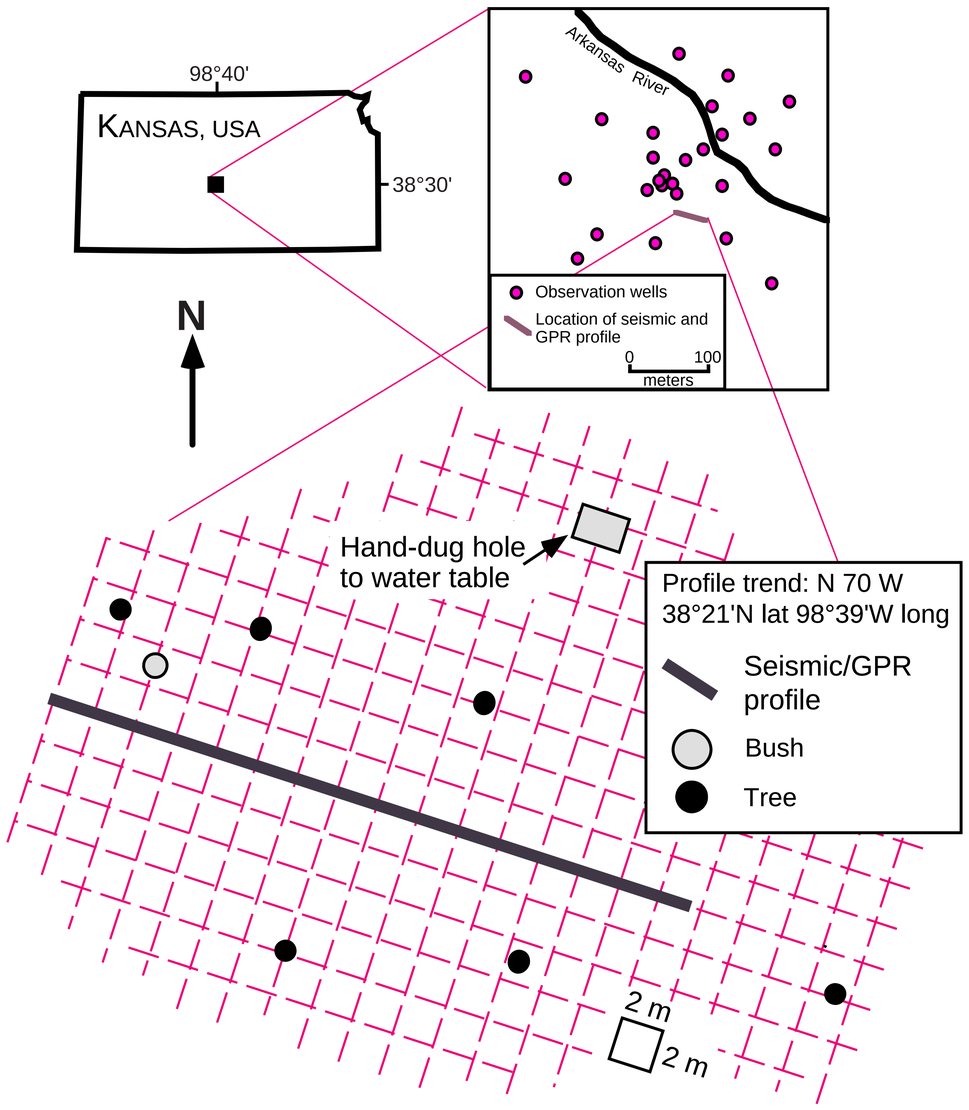

Figure 1. Location of the test site on the Arkansas River flood plain. The inset at upper right indicates the positions of the observation wells used to constrain the geology in the vicinity of the test site.

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