Advances in groundwater exploration: the roles of ASTER and SRTM data

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The most productive sources of groundwater are sediments composed mainly of quartz and feldspars, or carbonates. The dominance of these minerals encourages high permeability and high yield. Where these minerals are abundant in areas of crystalline basement rocks, hydrogeologically productive conditions occur in fracture zones, often the only significant groundwater sources in such terrains. Rocks that contain high proportions of fines (clay, mica and silt) or ferromagnesian silicates that rapidly break down to fines are usually poor aquifers. Should disaster strike, advance knowledge of the most promising aquifers helps to focus the search for emergency water supplies. More importantly, clean water supplies are assured during normal times.The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) produces low-cost data (free for bona fide educational users) in the visible to short-wave infrared and thermally emitted parts of the spectrum. That spectral coverage makes remote mapping of quartz, feldspar and carbonate abundances possible. Clays and other minerals that clog pore spaces are equally amenable to remote detection and mapping in rock and soil exposures. Hitherto, only costly, airborne hyperspectral data offered such mineral-mapping potential; ASTER has global coverage. Free topographic elevation data from the Shuttle Radar Topography Mission (SRTM) complement ASTER, by enabling detailed mapping of terrain features that relate to rocks and soils, drainage patterns in unmapped regions and structural geology. Structural information is important in assessing the subsurface location and extent of “hard-rock” aquifers. Large disaster-prone tracts in Africa, such as the Horn, lack detailed geoscientific information to support swift responses to drought and the water needs of displaced people. Combined ASTER and SRTM data help resolve that deficiency and permit reconnaissance evaluation of hydrogeological conditions that indicate potential well sites and areas that would benefit from artificial enhancement of natural groundwater recharge.The main hindrance to aquifer recharge in arid and semi arid areas is a marked reduction of surface infiltration. This is because winnowing-out of fines by sheet wash creates an impervious desert pavement made of interlocking coarse debris, especially in areas of basement rocks. Thick unconsolidated sediments, which under other conditions would be good aquifers, are poorly recharged if such pavement coats their surface. In basement areas, a large proportion of blocks in the pavement are resistant vein quartz (usually a minor component of bedrock). Evaluating groundwater in such sedimentary cover requires maps of desert pavement. The excellent quartz detection of ASTER thermal data makes that possible on a regional scale for the first time.A combination of mineralogical assessment from ASTER data plus structural and topographic information from SRTM is used to address the groundwater potential of alluvium and colluvium, stratiform aquifers and fractured crystalline basement in drought-prone areas of the Horn of Africa. Similar techniques applied to catchment areas that supply material to active drainages help to assess the likelihood that sediments that fill surface reservoirs can themselves become high-yielding, artificial aquifers.