COST EFFECTIVE GEOCHEMICAL TECHNIQUES FOR OBSERVING FLUID PATTERNS AND COMPARTMENTATION IN COALBED METHANE RESERVOIRS: LESSONS FROM THE SAN JAUN BASIN.

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ABSTRACT

The most productive coalbed methane reservoirs are regional aquifers. Because these aquifers commonly exhibit geochemical gradients, spatial and temperal mapping of such gradients can provide powerful tools to synoptically view reservoir plumbing. Two type gradients are common. The first type results from the simple mixing of relatively dilute recharging fluids, and more concentrated basinal fluids encountered along the flow path to discharge. Such gradients become evident when examining chloride concentrations, the most unreactive element at low concentrations. The second type of gradient results from geochemical reactions that change the dissolved ion concentration along the flow path from recharge carbonate dissolution gradients and by sulfates liberated in solution during pyrite oxidation near outcropping coal seams. Shallow ground waters, on the other hand, can be typically characterized by gradients indicating both sulfate reduction and carbonate precipitation reactions. Deeper ground waters can be characterized by gradients resulting from cation exchange reactions that release sodium ions in solution, and by charge balancing bicarbonate concentrations derived from bacterial respiration and metabolism localized in reservoir porosity.

Both mixing and reaction gradients can easily be observed using simple protocols for collecting fluid samples and low cost suites of laboratory analyses. The resulting data can then be applied to developing a set of geochemical indices that can be plotted on maps as either contours or coded symbols indicative of differing mixing equations. Two geochemical index mapping techniques are most useful. The first technique involves taking a geochemical "snapshot" by sampling produced waters from a number of wells over a large area. Changes in contour density among normalized geochemical indices over an area makes it possible to identify regions with differing flow rates within a reservoir. Alternatively, coded maps of different mixing populations can highlight sharply linear discontinuities that indicate the presence of flow barriers and baffles. The second technique requires periodic sampling of produced waters, optimally at a frequency of every three months. By monitoring how geochemical index gradients change with time, it is possible to oberve directional flow in the reservoir. Monitoring changes in chemical composition prior to and following well workovers also allows one to examine the relative contribution of produced fluids from stacked coal seams. Combining both spatial and temporal techniques is the most effective way to observe reservoir drainage patterns, flow anisotropy, fracture-dominated flow, and flow barriers and baffles.

Maps produced using spatial and temporal mapping techniques are valuable tools for the reservoir engineer. They help to target infill drilling locations, to constrain history matching of produced fluids, to prioritize well test patterns, to address correlative rights issues, and to help solve what is becoming a significant problem - groundwater quality litigation targeting coalbed methane producers. When used proactively, geochemical mapping techniques can significantly reduce the costs normally associated with coalbed reservour development practices. This paper focuses on providing examples of spatial and temporal geochemical data gathered during two significant groundwater quality disputes in the San Jaun Basin.

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