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Groundwater evolution and recharge areas for the Friuli Venezia Giulia confined and unconfined aquifers, northeast Italy

F. Cucchi, **G. Franceschini**, F. Treu and L. Zini

Department of Geological, Environmental and Marine Sciences,

University of Trieste

Via E. Weiss 2, 34100 Trieste, Italy

(giuliana.franceschini@units.it / Tel.: +39 040 55822052; fax: +39 040 5582048)

The geochemistry and isotopic composition (H, O, Sr) of groundwater from the Friuli Venezia Giulia aquifers were investigated in an attempt to reconstruct the origin of the water, evaluate modes of water–rock interactions, and determine mean residence times of the groundwater. The regional hydrogeological situation of the Friuli Venezia Giulia Plain is characterized in the north by an extensive alluvial unconfined aquifer contained in Eocene to recent carbonate gravels. This area extends from the Pre-Alps to the resurgence belt. The resurgence belt is 2 to 8 km wide and 80 kilometers long. In this area the water table intersects the topographic surface forming numerous plain springs and rivers. The resurgence belt sets a geohydrological boundary between the Upper and Lower Friulian plain. In this strip the unconfined aquifer changes into a multi-layered confined that reach a thickness of up to 500 m. The multi-layered confined aquifers have been subdivided in shallow and deep confined aquifers, separated by a thick impermeable layer of silty material found at approximately 100 m depth. The unconfined and shallow confined aquifers are starting to face groundwater resources deficiency due to an increasing water demand. This problem is aggravated by an inadequate evaluation of groundwater resources in the region.

The chemical and stable isotope investigations of the unconfined and confined waters

have shown that the deep confined groundwaters have different signature in respect to the shallower waters. Four principal hydrochemical zones were recognized, which provided information on plausible recharge sources and groundwater chemical evolution. The data from this study suggests that the unconfined and shallow confined groundwaters are recharged by river water infiltrations and rainfall. This fast recharge process makes these groundwaters susceptible to contamination by discharge from urban areas and small-scale industries. The ^{14}C concentration for the deep confined groundwater varies between 0.8 and 0.9 ($\pm$0.1) pmc indicating a residence time that ranges between recent 23 and 27 ka. Significant late Quaternary sea-level fluctuations, associated with alternating cooler and wetter periods, would have changed the hydraulic gradients and partially or completely disconnected the deeper parts of the aquifer systems from the more active surface circulations. Comparison with deep confined aquifers in other regions of the Padain Plain indicates that the recharge rates of these deep confined aquifers are low and that, consequently, the deep groundwaters are impacted by over abstraction.