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Preferential flow characterization in fractured aquifer by injecting dissolved oxygen in boreholes

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A new approach to identify contributing fractures and wellbore flow in fractured and karst aquifers is presented. It is time efficient, low cost and based on a benign tracer: the dissolved oxygen (DO). The method was already applied by other scientists to test fractured crystalline rock wells. The DO method consists in elevating water DO concentration in a borehole by bubbling air at assigned water depths using a porous polypropylene tube (bubbler) connected to a compressed air tank with tubing. After the aeration, the resulting profile should be a linear increase in DO with depth due to the effects of water pressure on oxygen solubility. Any changes in the DO profile will be then observed when water flows into and through the well. DO dilution can be used to locate inflowing fractures and to define active flow zones in wells. If there is no change in the DO profile, a “dead zones” in the well is present, that is to say no flow is taking place or can be identified.

The DO tests in this work have been carried out in the industrial area of Bari, at the experimental station, constituted by five wells drilled at the CNR-IRSA. The wells penetrate karstic limestone.

Results show enhanced flow through at depths between 32 and 37 meters below the water level: DO concentrations decrease until they reach values close to 0 mg/l.

DO curves show also the presence of inflowing fractures, as testified by the decrease in the DO concentrations due to the effects of water dilution, at depths of 4 and 9 meters (below the water table) in the north well, at 4 and 10 meters in the central well, and at 30 meters in the south well.

The benefits of utilizing DO as a tracer include ease of accessibility, low cost and time-efficiency as well as non-toxic nature of the tracer and no impact on flow conditions.