

THE PROTECTION ZONES FOR THE THERMO-MINERAL (M-TH) AQUIFER OF CHAVES (N PORTUGAL): HARD ROCK AND POROUS ROCK HYDROGEOLOGICAL CONSTRAINTS.

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A number of physical and chemical hydrogeological parameters both from the productive fractured hard rock aquifers and from the overlaying porous type aquifer are considered in order to configure the protection zones recommended for the sustainability of the Chaves (N Portugal) spa and geothermal plant. The hard rock aquifer is physically conditioned by a set of megascopic faults, which are seismically active to a minimum depth of 5kms. The M-Th water is visibly flowing upwards ($Q > 15\text{L/s}$) along the western marginal faults of the Chaves graben ($10 \times 3\text{km}^2$), using discrete, structurally defined, channels. The recharge is maintained through deep-reaching faults, that are supplied by the overlaying porous aquifer that corresponds to the Late Cenozoic sediments that fill the graben. The envisaged Na-HCO_3^- , SiO_2 , and CO_2 rich, high TDS, hot (73°C) M-Th water is affiliated on chemical reactions, that are going on in the deep seated (ca 4km) "reservoir", between the infiltrated Lower Holocene rainwater and the Lower Paleozoic, or Upper Proterozoic (?), metamorphic rocks and hercynian granites. The irregular and discontinuous radar shaped envisaged protection zones take into account: a) the most hydraulically significative fractures of the basement, b) the double role - recharge and protection - played by the overlaying sediments, c) the physical barrier for the M-Th deep runoff, played by the lithological structure and a large transversal (ENE-WSW) fault zone and a superimposed diagonally oriented graben-horst, d) the location and the depth of the productive boreholes, e) the specific discharge rate, f) the piezometric heads of both the M-Th and regional aquifers.