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Monitoring, utilization and sustainable development of a low-temperature geothermal resource: A case study of the Euganean Geothermal Field (NE, Italy)

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ABSTRACT

The Euganean Geothermal Field (EGF) and its thermal water (temperature from 63 °C to 87 °C) represent an important environmental and economic resource for the Veneto Region (NE Italy). Approximately 14.7×10^6 m^3 of hot water were exploited in 2015 through 142 boreholes from rocky aquifers located at different depths. The water is mainly used for balneotherapy feeding approximately 240 pools. Hundreds of thousands of tourists visit the spa facilities of the EGF every year, producing a huge income for the regional economy. The Euganean thermal resource suffered a significant anthropic impact during the 20th century related to the development of the local tourism industry. Hydrogeological data and information about the utilization of the resource spanning the century are analyzed to evaluate this impact with the aim of assessing the sustainable utilization of the thermal resource. In particular, the potentiometric levels of the thermal aquifers are affected by seasonal variations (i.e., decreases during the spring and autumn, recoveries during the winter and summer) induced by the different flow rates related to the tourist seasons. Similarly, the historical reconstruction of the level shows a decrease during the initial and middle parts of the 20th century followed by a gradual recovery up to the present. The reduction of the level was related to the growth of the tourism industry attested by the increase in exploitation, wells, mining claims and tourists. The limitation of the flow rate and its continuous monitoring have produced the observed recovery since the 1990s. The performed reconstruction suggests that the present flow rate (approximately 14×10^6 m^3/y) produces an acceptable drawdown preserving the Euganean thermal resource for future generations and maintaining a constant income for the regional economy. This work attests that thermal resources for balneotherapeutic purposes could be affected by overexploitation and depletion. Therefore, their sustainable utilization has to be achieved through specific management policies, preserving their important environmental and socio-economic values.

1. Introduction

The renewable and sustainable usage of natural resources is one of the main tasks of the 21st century. The European Commission noted the importance of using natural renewable resources to reduce greenhouse gas emissions and comply with the Kyoto Protocol (European Parliament, 2009). Thermal water is a well-established example of a renewable resource that should be used while achieving its sustainable development. Several authors discussed the renewability and sustainability of geothermal resources (e.g., Burnell et al., 2016; Mongillo and Axelsson, 2010; Rybach and Mongillo, 2006; Shortall et al., 2015). Renewability describes the ability of a system to replace an amount of removed resource on a fixed time scale (Stefansson, 2000), and it depends mainly on the geological and hydrogeological features of the regional system. Sustainability refers to the development of a resource in such a way that meets the needs of the present without compromising the ability of future generations to meet their own needs (Axelsson, 2010). A sustainable flow rate with an acceptable drawdown depends mostly on: i) the local hydraulic properties of the reservoir (i.e., transmissivity, hydraulic conductivity and storativity); ii) how the resource is exploited including the mode of utilization and the possible technological advances in its exploration/extraction; iii) the social,

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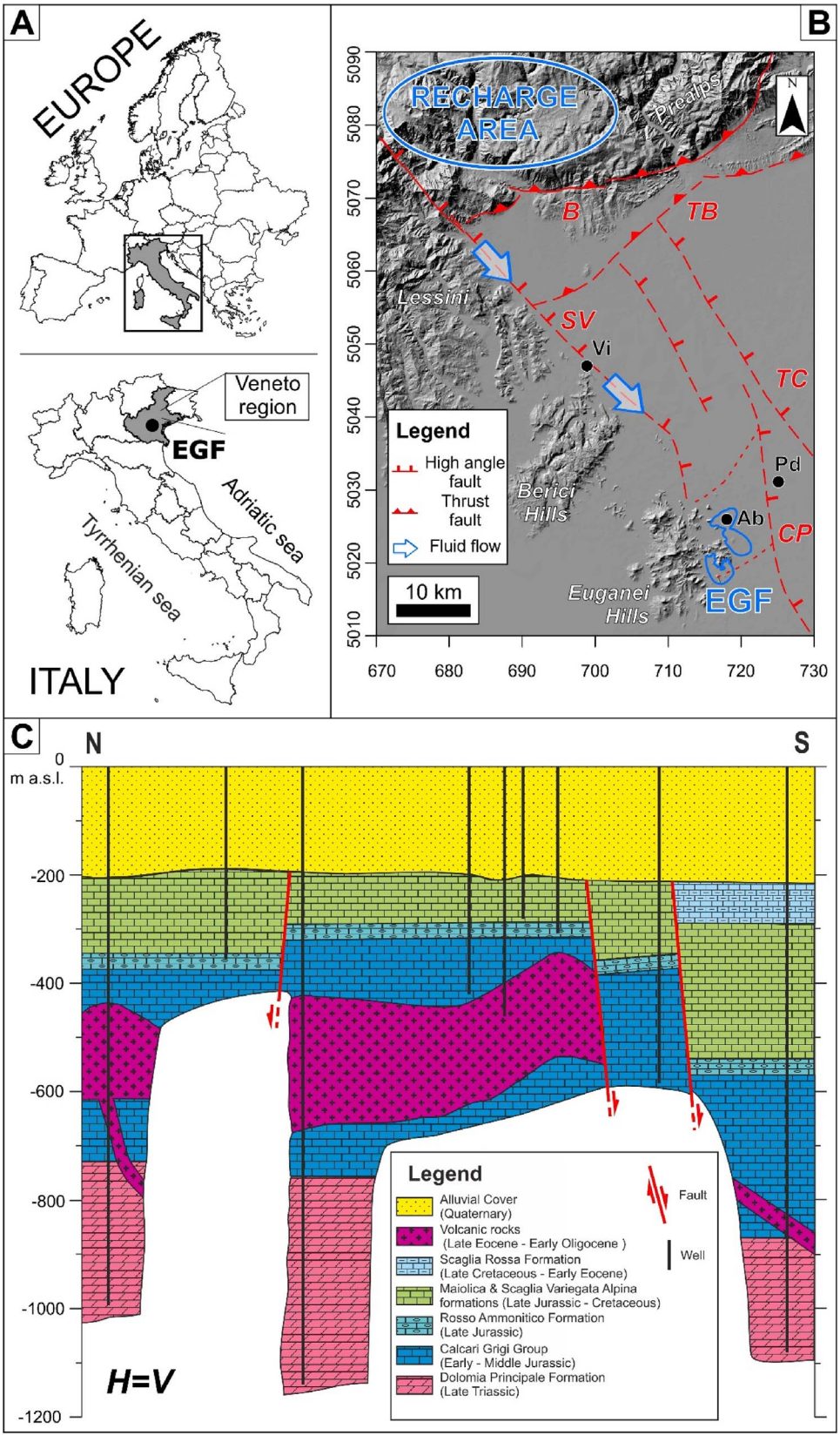

Fig. 1. (A) The Euganean Geothermal Field (EGF) is located in the central part of the Veneto Region (NE Italy). (B) Schematic structural sketch of the central Veneto. The regional faults fragmenting the subsurface (B: Bassano thrust; TB: Thiene-Bassano thrust; SV: Schio-Vicenza fault; CP: Conselve-Pomposa fault; TC: Travettore-Codevigo fault) and the principal features of the Euganean Geothermal System are shown (i.e., recharge area in the Veneto Prealps, preferential flow path along the Schio-Vicenza fault, outflow area corresponding to the EGF). The main cities (Vi: Vicenza; Pd: Padua; Ab: Abano Terme) are also reported. Map coordinates are UTM (zone 32N) system using WGS84 datum. (C) Cross-section of the EGF subsurface (trace in Fig. 3) showing the Mesozoic to Cenozoic bedrock fragmented by the network of faults. The horizontal scale corresponds to the vertical scale.

economic and environmental impacts of its utilization. The sustainable exploitation of thermal resources can be evaluated using mathematical models (e.g., O'Sullivan et al., 2010; Sarak et al., 2005; Scott et al., 2016), but they have to be supported by exhaustive datasets on the status of the thermal resource and on its utilization.

The Euganean thermal water is one of the most important and economically profitable water-dominated, low-enthalpy, geothermal resources in Italy and in the entirety of southern Europe. The related Euganean Geothermal Field (EGF) extends on a plain band of 25 km^2 to the SW of the city of Padua in the central part of the Veneto Region