

**MODELING KARST SALTY SPRINGS IN COASTAL CARBONATE AQUIFERS
(S'ALMADRAVA, MALLORCA, SPAIN)**

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ABSTRACT

Several Mediterranean coastal springs share the feature of discharging a high salinity water (presumably with a considerable proportion of seawater) above sea level. S'Almadrava spring is one of them, but has some special features that make it different. S'Almadrava is located in the Pollença area in the north-east of the Majorca Island, about 2 km inland and at an elevation of 6 m.a.s.l.. The geology of the area is controlled by a thrust imbricate system with a transport direction to the NW, that involves Upper Paleozoic to Middle Miocene rocks. Calcareous materials from Liasic present the higher hydraulic conductivity values because karsts processes. Both karsts and seasonal variations in recharge appear to control groundwater flow.

The S'Almadrava discharge has been monitored for flow rate, temperature, and electric conductivity almost continuously for more than 10 years ago, besides periodic chemical analysis. Measured yearly discharges oscillate between 5 and 30 Mm³ α⁻¹, with a 14.5 Mm³ α⁻¹ average. Maximum peak discharge is 8.5 m³ s⁻¹. Temperature and EC fluctuate in response to variations in discharge rate, with values of 16-24°C and 4-30 mS cm⁻¹, respectively. This high salinity prevents the human use of this important amount of water in a tourist area with a large summer demand. EC tends to increase when flow rate decreases. However, the highest values of EC are associated to sharp increases in discharge after the first heavy rains following a dry period.

The strong relationship of temperature and EC with the aquifer recharge and regional flow, the structural and stratigraphic information from previous studies and preliminary geochemical studies allow us to qualitatively model the system. Seawater, mixed with fresh water, discharges above sea level, because the excess elevation (6 m) is balanced by the excess in density of seawater above that of the mixture. This explains why, up to a point, salinity increases with reducing discharge. Also, after a long dry period, fresh water head drops, allowing sea water to flow into the aquifer, which explains the high salinity of the early rainy season discharges.

This conceptual model explains some of the observed features of S'Almadrava, but it suffers some limitations. For example, sea water depth nearby is not sufficient. SUTRA is being used to model aquifer flow and spring discharge in a 2D vertical cross section, in order to help setting constraints to the above difficulties and to gain some quantitative insights. This model would be a useful tool to the management of this important water resource.

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