'Evidence' for transition between Authigenic and Allogenic Aquifer functioning related to Regional Uplift and Sea Level Change in the Plymouth Coastal Karst Aquifer

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Easterbrook, C. and Smith, R. 2018. 'Evidence' for transition between Authigenic and Allogenic Aquifer functioning related to Regional Uplift and Sea Level Change in the Plymouth Coastal Karst Aquifer. *Geoscience in South-West England*, **14**, 198–206.

The Plymouth Coastal Karst Aquifer comprises Middle to Late Devonian limestones and underlies much of the early urban centres of Plymouth and Stonehouse. Whilst once important as a source of water the aquifer is now only used to supply limited water supply to industry, the aquifer becoming contaminated by saline intrusion in the 19th century. A tentative model for the development of the aquifer and the major limestone gorge complex which dissects it over the Middle and Late Pleistocene is presented. This model is based on regional and recessional uplift estimates and recent global eustatic sea level estimates. Periods when the aquifer may have functioned authigenically are linked to periods of high sea level and haloclinal cave development. Allogenic aquifer phases are linked to the development of vadose engulfment and the downcutting of the Limestone Gorge complex. Two such phases are identified in the western portion of the aquifer associated with the former Sour Pool. A tentative chronology of the phases and the development of the gorge is discussed in relation to the proposed uplift model. The maximum elevation of the aquifer suggests that the aquifer may have developed over the last 400 to 600 kyr. The development of the aquifer is considered in relation to other coastal aquifers in south Devon.

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Keywords: Plymouth Sound, karst landscape, caves, hydrogeology

Introduction

The Plymouth Coastal Karst Aquifer (Fig. 1) is a principal Environment Agency (EA) coastal telogenetic (Choquette and Pray, 1970) limestone aquifer with a long history of urban and industrial development (SWARF, 2008).

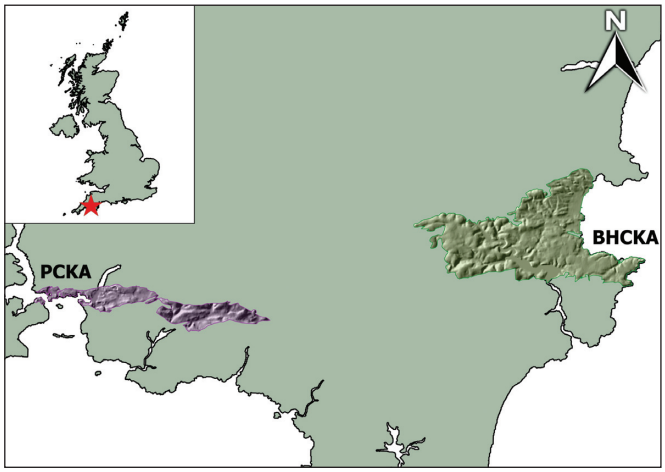

Figure 1. *Location Map, showing the relative locations of the PCK and BHCK aquifers on the south coast of Devon. This figure contains public sector information, licensed under the Open Government Licence v3.0 from the Environment Agency.*

The karst limestones have had a long association with human activity. Neolithic or earlier humans occupied or were deliberately interned in the limestone caves or shafts which connected directly with the surface (*c.f.*, Sutcliffe and Lewarne, 1977; SWARF, 2008) The medieval town of Plymouth grew up around the natural inlet known as Sutton Pool, obtaining much of its water supply from numerous wells and cisterns dug into the limestone and whose former locations are discernable from present-day road names. After the completion of Drake's Leat, which brought a reasonably reliable source of clean water to Plymouth from Dartmoor, the importance of the limestone aquifer to supply water reduced significantly. During the early nineteenth century boreholes were sunk to supply water to a number of local breweries or to provide local private water supplies in residential areas. A recent estimate of the current utilisation of the aquifer indicates that approximately 10% of the possible annual yield of 650 Mgal is used for industrial water supply with no licenced potable supplies (Roxburgh, 1983). This estimate is accounted for on the basis of the annual effective rainfall only and does not take account of any subterranean groundwater exchange to the limestone from the surrounding non-carbonate rocks. The current aquifer system developed in the limestone is limited to secondary permeability related to solution widened fissures and cavities. Storage is limited and the aquifer responds rapidly to recharge. There is also evidence that parts of the aquifer are directly connected to the sea. The degree of connection, however, does not appear always to be related to distance from the coast (Roxburgh, 1983).