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Assessing seawater intrusion in an arid coastal aquifer under high anthropogenic influence using major constituents, Sr and B isotopes in groundwater

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Abstract
The La Paz aquifer system (Baja California Sur, Mexico) is under severe anthropogenic pressure because of high groundwater abstraction for urban supply (city of La Paz, around 222,000 inhabitants) and irrigated agriculture (1900 ha). In consequence, seawater has infiltrated the aquifer, forcing the abandonment of wells with increased salinity. The objective of this study was to assess seawater intrusion, understand the hydrogeochemical processes involved and estimate the contribution of seawater in the wells tested. The aquifer comprises mainly the alluvial filling and marine sediments of a tectonic graben oriented north-south, in contact with the Gulf of California. Groundwater samples were collected in 47 locations and analyzed for major constituents. A subset of 23 samples was analyzed for strontium and boron concentrations and isotopic signatures ($^{87}Sr/^{86}Sr$ and $\delta^{11}B$). Results were interpreted using standard hydrochemical plots along with ad hoc plots including isotopic data. Seawater intrusion was confirmed by several hydrogeochemical indicators, such as the high salinity in areas of intense pumping or the Na^{+}-Ca^{2+} exchange occurring in sediments that were previously in chemical equilibrium with fresh water. However, seawater contribution was not sufficient to explain the observed concentrations and isotopic signatures of Sr and B. According to the isotopic data, desorption processes triggered by a modification in chemical equilibrium and an increase in ionic strength by seawater intrusion significantly increased Sr and probably B concentrations in groundwater. From a calculation of seawater contribution to the wells, it was estimated that one-third of the sampled abstraction wells were significantly affected by seawater intrusion, reaching concentrations that would limit their use for human supply or even irrigated agriculture. In addition, significant agricultural pollution (nitrates) was detected. Planned management of the aquifer and corrective measures are needed in order to invert the salinization process before it severely affects water resources in the long term.

SciVal Topic Prominence
Topic: Hydrochemistry | groundwater | irrigation purposes
Prominence percentile: 96.828

Reaxys Database Information

View Compounds

Author keywords
$^{87}Sr/^{86}Sr$; Cationic exchange pool; La Paz aquifer; Overexploitation; Salinization; $\delta^{11}B$

Indexed keywords

Engineering controlled terms:	Abandoned wells; Agriculture; Aquifers; Chemical modification; Groundwater; Groundwater geochemistry; Groundwater resources; Indicators (chemical); Ion exchange; Ionic strength; Isotopes; Mercury (metal); Pollution; Salt water intrusion; Seawater; Strontium; Submarine geology; Water resources
Engineering uncontrolled terms	Agricultural pollution; Anthropogenic influence; Anthropogenic pressures; Cationic exchange; Groundwater abstraction; Hydrogeochemical process; Overexploitation; Salinization
Engineering main heading:	Hydrochemistry
EMTREE drug terms:	Boron; calcium ion; ground water; isotope; nitrate; sea water; sodium ion; strontium; strontium 86; strontium 87; unclassified drug
GEOBASE Subject Index:	boron isotope; coastal aquifer; exploitation; groundwater abstraction; human activity; ion exchange; saline intrusion; salinization; strontium isotope; water chemistry
EMTREE medical terms:	Aquifer; Article; cation exchange; concentration (parameters); controlled study; desorption; ionic strength; salinity; sea pollution; sea water intrusion
Regional Index:	Baja California Sur; Gulf of California; México [North América]; Pacific Ocean

Chemicals and CAS Registry Numbers:
boron, 7440-42-8; calcium ion, 14127-61-8; nitrate, 14797-55-8; sodium ion, 17341-25-2; strontium, 7440-24-6

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