

CLUSTER ANALYSIS AS A TOOL FOR COMPARTMENTALIZATION OF FORMATION WATER TYPES IN THE SANTOS BASIN

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The characteristics of formation waters are important inputs for production development projects in the pre-salt fields. The compositional variations of the waters are essential to guide actions aimed at combating incrustation processes in the equipment responsible for lifting and flow. The objective of this study was to correlate the characteristics of the formation water families found with the geological characteristics of the field in the Santos Basin (Brazil). To this end, the research established a methodological procedure composed of two routines for classifying the formation waters of the field in a semi-automated way, with the unsupervised k-means algorithm as the analytical basis. The input variables used were the ionic compositions from the water analysis, and the following ions were selected: magnesium, barium, calcium, lithium, potassium, strontium, sulfate, bicarbonate, bromide, chloride and boron. The first classification routine aimed at an exploratory analysis of the data to observe the characteristics of the samples and the performance of the algorithm, using all the samples in the database. The methodology comprised data standardization, PCA, determination of the number of groups, k-means processing, and interpretation of the results. The second classification routine suppressed drilling fluid samples and increased the number of groups for more detail. The segmentation provided ten groups of formation waters, of which four corresponded to contaminated or non-representative samples. Two other groups, Medium-K-Sr and High-B, evidenced the ionic variations within the coquinas of the Itapema Formation (Jiquiá age), characterized by the homogeneous distribution of the Medium-K-Sr group throughout the central portion of the field, but with increasing boron values toward the northeastern area. Three groups comprised variations within the Barra Velha Formation (Alagoas age), namely: High-HCO₃, High-Ba-Li and High-Cl. The first describes the composition of samples from the western of the field, where a suspended aquifer is noted at shallower depths than the main aquifer. The second isolates the extreme northern region and the third, in turn, the northwestern region. Finally, the last group named High-K-Sr, presents in samples from both formations and describes a direction of potassium and strontium enrichment towards the south and southeast of the field.

MAP OF FORMATION WATER TYPES

