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Separation of trace elements in saline matrices: a new chromatographic approach

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The separation and analysis of trace elements from saline matrices pose significant challenges due to the complexity of the analytes. In this study, we explore the efficacy of ion chromatography employing a cation exchange resin for the selective separation of trace elements including Li, V, Fe, Cu, Ga, As, Rb, Sr, Y, Cd, Sn, Cs, Ba, REE, Tl, and Bi from a saline matrix comprising Na, Mg, K, Ca, and Mn.

The AG-50W resin, renowned for its high efficiency in cation exchange processes, was packed into chromatographic columns to facilitate the separation of target analytes. The separation mechanism is based on the differential affinities of cations towards the resin, allowing for the elution of trace elements of interest while retaining interfering matrix ions.

To achieve this result, a saline standard sample was prepared in a clean laboratory adding to a pure NaCl powder a mixture of multiple elements, with precise known composition, to simulate a salt matrix. To assess the reliability of the standard sample and validate the method, a part of its chemical composition was analyzed in two other laboratories using different methods.

Experimental conditions including resin volume, mobile phase molarities, and numbers and volumes of the elution steps were optimized to achieve maximal resolution and recovery. The target analytes were eluted in groups in four distinct elution steps over a total of seven, characterized by different volumes and molarities of hydrochloric acid, to minimize the interference from matrix ions.

The developed chromatographic method demonstrated excellent separation efficiency and resolution for the target trace elements within the saline matrix, with a recovery near 100%. Quantitative analysis of the separated analytes was performed by ICP-MS technique, ensuring accurate determination of trace element concentrations.

The proposed method offers a reliable approach for the selective separation and quantification of trace elements in saline matrices, making it a promising tool for the analysis of complex matrices. Future research will focus on the application of this method on naturally occurring evaporitic salts. This exploration aims to delve deeper into the applicability and efficacy of the introduced technique within the context of natural saline environments.