Combining indicators analysis and chemometrics to trace the geographical origin of crude oil

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Geographic traceability is crucial to global oil spill safety. This study discusses the possibility of using multivariate statistical methods combined with multi-indicator analysis to identify samples from five major source countries of crude oil imports to China. The physicochemical properties and trace elements of crude oil were detected by Petroleum product standards and inductively coupled plasma atomic emission spectrometry (ICP-AES). Eight indexes (moisture, density, sulfur content, acid value, organochlorine, carbon residual, V, and Ni) were analyzed. Principal component analysis (PCA), hierarchical clustering analysis (HCA), Orthogonal projections to lateen structures- discriminant analysis (OPLS-DA), and other multivariate data analysis methods were used to determine the geographical origin of crude oil samples. Satisfying results have been obtained by using PCA to reduce the dimensions of the indicators of crude oil from different sources. It allows the reduction of 8 variables to 3 principal components and accounts for 80.06% of the total variance. The HCA shows five clusters corresponding to five sources of crude oil. This will help improve the utilization rate of crude oil with different characteristics, improve the quality of crude oil trade, and ensure the high quality of crude oil trade. For the sample set used for modeling, the model's accuracy was 97.19% after OPLS-DA optimization. These results show that multi-index analysis and stoichiometry are practical tools for identifying crude oil origin, filling the technical gap in rapidly identifying crude oil origin.