Matlab Implementation of the Maucha Diagram and Its Application in Hydrochemistry (Postprint)

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Abstract

The content of soluble ions in water and the proportional relationships among various ions constitute important indicators for water quality assessment; however, conventional methods cannot simultaneously reflect both aspects. Maucha diagrams can represent both the total concentration of eight major anions and cations and the relative concentration of each ion, thereby accommodating both absolute and relative ion contents, which demonstrates strong practicality. Nevertheless, the lack of professional software for generating Maucha diagrams has significantly constrained their practical application. This study introduces the evolutionary development of Maucha diagrams, delineates the methodology for establishing coordinate systems and determining coordinate values for various diagram components during plotting, and elaborates on the programming workflow for computer-generated Maucha diagram output using Matlab. Finally, using the eastern region of the Hunshandake Sandy Land in Inner Mongolia as a case study, it demonstrates the application of Maucha diagrams in hydrochemical analysis of natural water bodies. The application reveals that Maucha diagrams exhibit substantial advantages in reflecting sample mineralization, indicating both relative and absolute ion concentrations, classifying water chemistry types, and conducting spatial analysis of hydrochemical data. They can significantly enhance the visualization capabilities of hydrochemical data, enrich the application of hydrochemical diagrams in hydrogeology, and provide a reference basis for deeper analysis of hydrochemical data.

Full Text

Preamble

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Title

Plotting Mauch Diagram based on Matlab and its applications on hydrochemistry

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Abstract

The content and proportion of soluble ions in water are important indicators to assess water quality, but common methods used in hydrochemistry cannot reflect the two relationships simultaneously. Mauch diagram not only reflects the total concentration of eight main anions and cations in water (i.e., CO^{2}, Cl, SO^{2}, HCO, Mg^{2}, Ca^{2}, Na and K), but also indicates relative and absolute concentrations for each ion simultaneously. Thus, the Mauch diagram is deemed to be very practical. However, due to the lack of professional software to plot Mauch diagram, the application of this diagram is very limited in hydrochemical research.

In this paper, firstly, we introduced the evolution history of Mauch diagram which was proposed by Mauch in 1932 and developed by Hedgpeth and BROCHE. Secondly, we introduced the components of Mauch diagram and its implications. This diagram makes up of a circle and eight quadrangles inside. The area of the tangent 16-sided polygon in the circle is utilized to represent the total concentration of eight anions and cations, and the area of the eight quadrangles represents the content of eight ions. In addition, the total cations and anions are supposed to submit the charge balance principle and the mass balance principle. Thirdly, the methods of how to establish a coordinate system and determine the coordinates of the circle and quadrangles in Mauch diagram were introduced in detail. Fourthly, the program flow of how to plot Mauch diagram based on Matlab was stated. Finally, taking the eastern Hunshandake Sandy Land in Inner Mongolia, China as an example, this paper illustrated the applications of Mauch diagram in the field of hydrochemical analysis for natural waters.

The Hunshandake Sandy Land belongs to a climate transition zone near the middle-latitude boundary of semi-humid and semi-arid to arid climate. Eleva-

tions in Hunshandake Sandy Land decrease from ca. 1300 m in the southeast to ca. 1000 m a.s.l. in the northwest, while mean annual precipitation decreases from ~450 mm in the southeast to 150 mm or so in the northwest. Since natural water in Hunshandake Sandy Land is characteristic of high concentration of NO and very low concentration of CO^2, we used NO instead of CO^2 to plot Mauch diagram with Matlab. Before plotted Mauch diagram, we checked the ion data and only charge balance and mass balance data were used.

Applications show that Mauch diagram has strong advantages in reflecting the total concentration of anions and cations, indicating the relative and absolute concentrations ions, judging the hydrochemical type of water body and spatial analysis for hydrochemical data. Compared to other computer languages, the Mauch diagram program written by Matlab can run on almost all kinds of computer systems, and have better readability and visualization. Moreover, based on hydrochemical characteristics of certain study area, the program can be developed to adapt to new situations, such as in this paper we use NO rather than CO^2 to plot Mauch diagram. Thus, the application of the diagram may improve the visual expression ability for hydrochemical data, enrich the application of diagrams in hydrochemistry, and provide a reference for further analysis of hydrochemical data.

Keywords: Mauch Diagram; hydrochemistry; Matlab; plotting; applications

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Figure and Table Captions

Fig. 5 Application of Mauch diagram in Hunshandake Sandy Land

Fig. 6 Application of Mauch diagram in spatial analysis for hydrochemical data

Tab. 1 Hydrochemical classification of natural water in Hunshandake Sandy Land

Note: Figure translations are in progress. See original paper for figures.