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Discrimination of Pb-Zn deposit types using the trace element data of sphalerite based on Deep Learning

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Different types of ore deposits exhibit distinct metal sources, physicochemical conditions, and ore-forming processes. Sphalerite, a key sulfide in Pb-Zn deposits, contains trace elements that can be utilized for classifying Pb-Zn deposit types. However, traditional binary discrimination diagrams often struggle to discriminatite mutiple Pb-Zn deposit types. In this study, we utilize deep learning to extract information from the geochemical dataset of sphalerite, demonstrating that combining deep learning with sphalerite geochemical data can effectively discriminate Pb-Zn deposit types. The trace element data of sphalerite were collected from five distinct types of Pb-Zn deposits, including sedimentary exhalative (SEDEX), mississippi valley type (MVT), volcanic massive sulfide (VMS), skarn, and epithermal deposits. By employing deep learning techniques alongside these trace elements in sphalerite, we have achieved a high degree of accuracy in discriminating the types of Pb-Zn deposits, with an overall precision of 99.47%. Additionally, we utilized a visualization tool to analyze the model's internal structure during the training process. Finally, The model's performance was rigorously evaluated using statistical metrics, confusion matrices, and ROC curves. This analysis further demonstrates the exceptional performance of our proposed deep learning model based on trace elements in sphalerite. We have established a comprehensive research process for classifying deposit types using deep learning: discrimination-visualization-evaluation. This provides a referential template for future AI applications in geochemistry and offers new insights into sphalerite research.

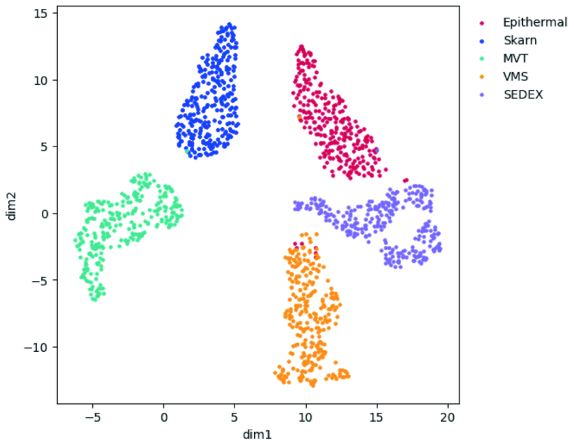

Fig. 1. Visualization analysis of deep learning model's internal structure

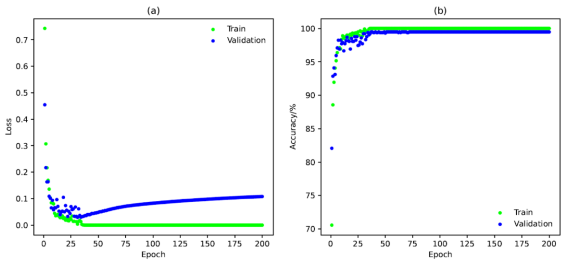

Fig. 2. The proposed model's loss and accuracy curves