Application of heavy mineral data in provenance analysis

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Abstract: Heavy mineral analysis plays an important role in provenance analysis that determines the location of the source region, source spreading and feeding direction. In the detailed results of previous studies and on the basis of reading a lot of literature, this paper expounds the important role of the four heavy minerals analysis methods in provenance analysis include: the traits of heavy mineral, typomorphic characteristic, stability factor, etc., then, state the advantage and disadvantage.

Keywords: heavy minerals; provenance analysis; source rock; stability.

INTRODUCTION

Heavy mineral analysis method is one of mature provenance analysis methods. Early heavy mineral analysis mainly based on its physical and optical properties. With the application of electronic probe, the characteristic that mineral geochemical differentiation can be fully utilized. Heavy mineral refers to the mineral which proportion is more than 2.86 in the sedimentary rocks, its resistance to abrasion and strong stability make it capability of more retained by parent rock characteristics. In the handling process of sedimentary detrital minerals and, the unstable heavy mineral gradually decreased with increasing of transport distance while the relative content of stable heavy mineral,gradually increased. The main content of heavy mineral analysis is to count the contents of all kinds of heavy minerals, and then, draw the distribution map of heavy minerals in the profile and plane, so as to explain the distribution of heavy minerals and control factors[1-3].

PROVENANCE ANALYSIS WITH THE TRAITS OF HEAVY MINERAL (TYPES, CONTENTS AND DISTRIBUTION)
Heavy mineral

Due to the different distances or different handling natural and geographical conditions, even from the same deposition area, different deposits may form individually, but the heavy mineral assemblage they contain should be the same generally (table 1), But as the impact of the passage of time or tectonic movement, the latter being eroded overburden, rock area exposed altered rock, heavy mineral assemblage also changed. Therefore, the use of heavy mineral types in the horizontal direction changes to the composition and content of recourse provenance and restoration rock, also available clastic rock characteristics and content changes to recourse provenance and restoration rock[2-4].

Table 1: different types of heavy minerals according to Pei Zhuangdi,1972

Source Rock	Assemblage of Heavy Minerals
acid magmatic rock	hornblende, monazite, rutile, sphene, zircon, tourmaline, magnetite
pegmatite cassiterite	fluorite, tourmaline (blue variant), garnet
basic magmatic rocks augite	basil pyroxene, hornblende, diopside, magnetite, ilmenite, titanium white, rutile
metamorphic andalusite	garnet, chlorite hard, blue amphibole, kyanite, staurolite, epidote, zoisite, sillimanite, corundum, sphene
sedimentary rocks zircon (round)	tourmaline (round), rutile, titanium white stone, iron ore

Single mineral analysis

The single mineral analysis is to choose one or several single-particle mineral geochemical and mineral source area compared obtain further information on the source rock. The single mineral grains heavy mineral analysis include: pyroxene, hornblende, epidote, staurolite, garnet, spinel, hard chlorite, tourmaline, zircon, apatite, rutile, ilmenite, olivine, etc. The content of the minerals, chemical composition and type, optical properties can be analyzed by electron microprobe. For

each heavy mineral characteristics and specific elements of content, with its typical chemical composition determination map or index to determine its provenance; single particle ratio also has heavy mineral content a certain sense the source region, monazite / zircon ratio (MZi) to display cases of deep sandstone provenance; garnet / zircon ratio (GZi) used to determine the sequence of the garnet is stable; apatite / Tourmaline ratio (ATi) indicates the sequence is affected by the acidic groundwater circulation, planar single grain weight changes can be used to determine the mineral content source direction, such as magnetite; can also use the cluster analysis and heavy mineral types, content Provenance and portfolio analysis, with strict symbiotic relationship between minerals, heavy mineral assemblage is so Provenance very sensitive indicator, in the same sedimentary basins, clastic sediments component consistent with the same period, while clastic sediments of different substances contained in different periods, which can be speculated that direction material sources[3,5-6].

HEAVY TYPOMORPHIC CHARACTERISTIC JUDGMENT PROVENANCE

Based on heavy minerals, including zircon, tourmaline, garnet, hornblende, epidote, pyroxene and rare staurolite, kyanite standard type features, combined with the type and degree of development of heavy mineral inclusions, the inclusions partition can be done.

It has a symbiotic relationship between mineral strict, so heavy mineral assemblage is anextremely sensitive Provenance indicator. In the same sedimentary basins, consistent detrital composition of deposits in the same period, while different in different periods of clastic sediments substance contained, whereby the use of heavy mineral type and content change map horizontally at different times, may material sources speculated that direction[8-10]. Heavy mineral composition analysis of the source area usefulness is rather high, especially in the more complex types of minerals, especially useful in areas controlled by many factors. Specific combinations, analytical methods based on the characteristics of different regions differ[9].

THE STABILITY FACTOR AND HEAVY MINERAL ZTR INDEX TO IDENTIFY THE PROVENANCE

Many different types of heavy minerals, weathering resistance is also different. Depending on the degree of weathering stability during handling heavy minerals will be divided into super-stable, stable, moderate and stable, unstable and very unstable 5 categories, super-stable heavy minerals are: rutile, zircon, tourmaline, anatase stable heavy minerals include apatite, garnet (low iron), titanium white, cross, monazite, biotite, ilmenite, magnetite, hematite, wollastonite, etc., moderate stable heavy minerals including epidote, kyanite, garnet (rich in iron),

sillimanite, zoisite, sphene, unstable heavy minerals are hornblende, actinolite, pyroxene, diopside Stone, basil pyroxene, andalusite, etc., very unstable minerals include olivine. The use of stable and unstable heavy mineral heavy mineral composition, heavy mineral content and calculated stability factor, analysis of the distribution and trends in the plane, to infer the distance detritus transport distance, with increasing transport distance, not stable minerals gradually reduced, the relative increase in the mineral content of stable heavy mineral stability coefficient increases accordingly, thereby determining the provenance direction and rock mineral components [11].

ZTR index value trends can indicate the direction of the study area was the source, ZTR index is the most stable heavy minerals 3 mineral zircon, tourmaline and rutile accounted transparent heavy minerals mineral percentages, ZTR The higher the index value represents the higher maturity of heavy minerals, the stronger the weathering of rocks subjected, on the contrary, represents the maturity of heavy minerals is low, rocks undergo weathering weak; with the increase of sediment transport distance and unstable weight It will become increasingly low mineral content, and the content of heavy minerals is stable growing, thus presumably the direction and position Antiquities source region, the sediment provenance and the distance from the ancient flow direction.

THE JUDGMENT WAS THE SOURCE OF HEAVY MINERALS OTHER METHODS AND MEANS

The type and content of the heavy minerals can be a direct indication of the nature of rock source area, the use of heavy mineral provenance determine the direction and type of rock as well as ways and means: the use of heavy minerals physical properties (such as color, shape, size, hardness, stability, etc.), and combinations thereof, stability mineral surface microstructure, crystalline and other judges provenance, opaque scrap metal oxides indicator sources[1,12].

THE ADVANTAGES AND DISADVANTAGES OF HEAVY MINERAL ANALYSIS PROVENANCE

Because mineral species are more preferably controlled by many factors in the effect of the application area. Mineral analysis taken heavy mineral grain size should also be noted, is generally believed 0.25mm-0.1mm and 0.1mm-0.01mm two size fractions of heavy mineral analysis is desirable. It should be noted that different rock properties, precision heavy mineral provenance analysis method is not the same, if the rock is metamorphic or igneous rock, heavy mineral nature late reformation small, can better reflect the nature of the source region, if rock is sedimentary rock, heavy mineral composition and content will vary deposition, diagenesis and change, then apply heavy mineral provenance discrimination should be careful. In addition, older age sediments, due to the heavy rock

minerals to retain the original information have been reduced, there might be discrepancies in the judgment provenance. For no heavy minerals or provide only a very small amount of heavy minerals rock force poor judgment (e.g. less heavy mineral data areas and limestone, dolomite and other heavy minerals containing small rocks), cannot accurately determine the source area The main sediment transport channel[12-15].

The use of heavy minerals Source analysis has its own advantages and limitations of the inevitable, during provenance analysis, in conjunction with the specific situation of the study area, fully consider the tectonic movements, erosion, sedimentation of debris and other factors on determination Influence of provenance, as much as possible using a variety of analytical methods provenance comprehensive analysis, mutual authentication, obtain accurate scientific conclusions.

CONCLUSION

In summary, the use of heavy minerals provenance analysis, has its own advantages and limitations of the inevitable, therefore, during the provenance analysis, in conjunction with the specific situation of the study area, while also fully consider the structure uplift, erosion and debris deposition to determine the impact of factors such as the source area, as much as possible using a variety of analytical methods provenance comprehensive analysis, mutual authentication, the only way to obtain accurate provenance analysis conclusions science. With the deepening of the study and analysis of electronic means of progress, heavy mineral analysis will continue perfecting.

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