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A Taxonomic Study on Primitive Euconodonts

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Primitive euconodonts are extremely abundant and varied in the Late Cambrian in western Shandong Province. Two new genera are established, including *Camconodontus* gen. nov. and *Laiwunodus* gen. nov. Among them the following species are described: *Camconodontus rotundatus* gen. et sp. nov., *Camconodontus* sp., *Laiwunodus lateronodus* gen. et sp. nov., and *Laiwunodus* sp. In addition, the Genus *Dasytodus* is emended, with *Dasytodus posteronodus* sp. nov. being added. The discovery of new species has greatly enriched and deepened the already known concept about primitive euconodonts. The study of the internal structure of conodonts facilitates the differentiation among primitive euconodonts as well as part of paraconodonts more correctly. Together with the internal structure, some important morphological characteristics are selected. Three types of primitive euconodonts and one type of paraconodonts easily confused with each other are differentiated, making the complexity on primitive euconodont taxa greatly simplified. And this work will bring much convenience to further studies on other related problems.

Key words: western Shandong, Late Cambrian, primitive euconodonts, paraconodonts, taxonomy

A Study on Miocene Biostratigraphy in Liaocheng, NW Shandong

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Recently the authors analyzed samples from the drillholes II₂₀ and VII₁₄ in Neogene strata between the Permian and Quaternary in Liaocheng, Shandong Province. A large number of spore-pollen and Ostracode fossils have been discovered. A palynology assemblage of *Magnastriatites-Ulmipollenites-Liquidambarpollenites* and an Ostracode assemblage of *Cyprinotus-Candona-Candoniella* are found. Through a comparison with the strata of northern Shandong, the Bohai Sea region, northern Jiangsu, the Weihe basin of Shanxi, the Songliao basin, the Longjing structural zone in the East China Sea Shelf basin etc., they should be ascribed to the middle Miocene in age.

Key words: Miocene, biostratigraphy, Liaocheng, Shandong

Dynamics of the Yinggehai Basin's Formation and Its Tectonic Significance

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The Yinggehai basin is located in the northwestern South China Sea, and is the seaward extension of the NW-trending Red River fault zone. Through researches in the basin's structures, and subsidence and tectonic-sedimentary migration processes, the authors propose that the Yinggehai basin is a sinistral transtensional rift basin from the Eocene to early Oligocene. From the late Oligocene to early Miocene, as affected by the sinistral shear movement of the Red River fault zone, the left lateral slip distance of the basin is about 53±2 km. The formation and evolution history of the basin reflects the influence history of the India-Tibet collision to the evolution of the South China Sea.

Key words: Yinggehai basin, tectonic-sedimentary migration, transtensional rift basin, evolution of the South China Sea

Ductile Shear Zones along the Northern and Southern Boundaries of the Central Tianshan Block

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This paper describes in detail the structural features of the central Tianshan block along the Houxia-Wuwamen section of the Urumqi-Korla highway. Based on field and microstructural observations, three ductile shear zones associated with the central Tianshan block were identified. The ductile shear zone occurring along the northern margin of the central Tianshan block has been studied before. It is a dextral one with a width of up to 10 km. The Ulatai ductile shear zone lying in the central Tianshan block is a sinistral one and the mylonite inside it is over 200 m wide. The ductile shear zone along the southern margin of the central Tianshan block is 5 km wide with large amounts of dioritic mylonite and ultra mylonite well developed inside it. Shearing criteria such as the S-C fabric indicate that it is a sinistral shear zone. The brittle boundary faults on the northern and southern sides of the central Tianshan block roughly coincide with the deformation center of the mylonite belt. The above shear zones must have very large strain accumulations, suggesting that the amalgamation of the tectonic units in the Tianshan region might have resulted from strike sliding. It is significant to study the space distribution, kinematics and total strain accumulation of the ductile shear zones for reconstructing the tectonics and paleogeography of the Tianshan ranges.

Key words: ductile shear zone, mylonite belt, kinematics, central Tianshan block

Evolution, Chronology and Depositional Effects of Uplifting in the Eastern Sector of the Tianshan Mountains

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Eight huge depositional successions from TC-0 to TC-7, which are dominantly shallowing and coarsening upward, have been recognized based upon 3 disconformable surfaces, K_2/K_1 , N_1/E_3 and Q_2/Q_1 and sedimentary facies associations in the Late Cretaceous-Cenozoic deposits in the Tianshan areas. Sandstone detrital model analysis indicates that the Mesozoic and Cenozoic sediments are characterized by different provenances such as the recycled orogen, undissected and magmatic arc. The compositions of sandstones and dense (heavy) minerals and their associations in the sandstones reflect a change in provenance between the Oligocene and Early Miocene, which is coupled with the depositional-tectonic evolution of the Tianshan. The apatite fission-track data show several major frequency clusters as 24.74 Ma at 48.84%, 15.98 Ma at 27.91% and 45.22 Ma at 11.63%, which are interpreted as the uplifting age intervals of the Tianshan. The ages of 65.6 Ma, 45.22 Ma and 32.60 Ma may be considered the initial unroofing ages, and together with the intervals of 24.74–15.98 Ma, 6.7–0.73 Ma and <0.73 Ma they represent the four major uplifting ages. Most of the ages of the molass formations are 8–1 Ma younger than the apatite fission-track ages of orogenic rocks, with only a few data being correlative, which reflects that there exists a depositional delay and coupling relationship between the orogenic evolution and the deposition within marginal basins. This study suggests that the initial uplifting of the Tianshan started in the Late Cretaceous. In the terminal Oligocene, the northern margin was developed earlier than the southern one, and the western parts of the former experienced more rapid uplifting than the eastern one. It was not until the Pliocene-Early Pleistocene that the uplifting shifted southward to the Turpan-Hami basin and the southern Tianshan.

Key words: Tianshan, uplift, deposition, chronology, evolution

Cenozoic Structural Characteristics and Mechanisms and Their Relationship with Oil and Gas Reservoir in the Biyang Depression

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The formation mechanism of the Cenozoic structure in the Biyang Depression is discussed according to the latest structural theories and research methods. The Biyang Depression superimposes the

Qinling orogenic belt, and its stratigraphic sequence suggests that its extension process can be divided into six extensional episodes. Before the 2nd member of the Hetaoyuan Formation (Eh_2 , middle Oligocene), the structural deformation was influenced by a NE-SW extensional stress and controlled by the Tanghe-Liyuan Fault, which was a normal fault with a left lateral slip component. From the Eh_2 member to the end of the Liaozhuang Formation (El , upper Oligocene), the structural deformation was influenced by a NW-SE extensional stress and controlled by the Biyang-Liyuan Fault, which was a normal fault with a right lateral slip component. During this period, the earlier structural styles were reformed in the deformation of the hanging wall of the Biyang-Liyuan Fault. At the end of the El , influenced by a NW-SE extensional process, a regional uplift and fault block tilting led to the erosion of the strata. Since the period Eh_2 , particularly from the end of the El , as the result of the heterogeneity of the NW-SE extension, a NW strike-slip fault became active, and influenced the structural activity of the cover.

Key words: Biyang Depression, structural characteristics, structural evolution

Geometric Descriptions of Distorted Structures of ABX_3 Type Perovskite and Application in Structural Prediction

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Perovskite-type oxides are important in material sciences, physics and earth sciences. The ideal perovskite structure has an ABX_3 stoichiometry and belongs to the cubic space group $Pm\bar{3}m$. However, there are several structural deviations from the ideal cubic structure, such as tetragonal $I4/mcm$, orthorhombic $Pbnm$ and so on. Geometrically, the distorted structures could be described with several models, for example, the tolerance factor, octahedral tilting and global parameterization method (GPM). This paper reviews the geometric parameters of these models and discusses the relationship between the ideal and distorted structures. The structure of perovskite $YbNiO_3$ and the structural deviations of $MgSiO_3$ and $ScAlO_3$ under increasing hydrostatic pressures are theoretically predicted and compared with the available experimental data.

Key words: perovskite, crystal structure, tolerance factor, octahedral tilting, global parameterization method

Single-Zircon U-Pb Isotopic Age of the Wulitong Granite in the Dajishan Area of Jiangxi and Its Geological Implications

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The Wulitong granite at Dajishan, Jiangxi Province, was considered an early-stage intrusion body related to the Dajishan tungsten deposit, which was formed in the early Yanshanian period. However, the temporal and spatial relationship between different intrusions of the Dajishan area is not clear, and some previous age data are contradictory to each other. The single-

zircon U-Pb dating method is used in the present study, and the age determined for the Wuliting granite is 238.4 ± 1 Ma, which belongs to the Indosinian period. In a comparison of petrology and geochemistry with adjacent granite plutons, it is suggested that the Wuliting granite should be attributed to the Indosinian age. Hence, there is no direct genetic relation between the Wuliting granite and the Dajishan tungsten deposit. The age determination of the Wuliting granite, as well as the new discoveries of more Indosinian granitic rocks in this area, indicates that the Indosinian movement might have played more important roles in South China than previously recognized. Based on this fact, the problem of the Indosinian movement and related granite in South China is also briefly discussed in this paper.

Key words: Wuliting granite, U-Pb zircon age, Indosinian, Dajishan

Age of the Jinchuan Copper-Nickel Deposit and Isotopic Geochemical Feature of Its Source

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The Jinchuan copper-nickel sulfide ore deposit is located in Jinchang, Gansu Province, China. It contains multi-useful components and is the largest nickel deposit in China. Its formation age has not yet been established although much dating work has been done. It is generally considered that the deposit was formed in the Mesoproterozoic at about 1508 Ma and its materials were from an upper mantle source, i.e. the depleted mantle source. However, the ideas are not supported by our newly-obtained Sm-Nd, Rb-Sr and Re-Os isotopic geochronological and geochemical data. This paper reports the data and discusses the age and origin of this deposit. The Re-Os isotopic data of dunite sulfide samples from the Jinchuan deposit define an excellent isochron of $t = 1043 \pm 28$ (2 σ) Ma, corresponding to $(^{187}\text{Os}/^{188}\text{Os})_i = 0.1503 \pm 50$ (2 σ), MSWD 1.3. The Sm-Nd isotopic data of ultramafic rocks of the deposit are dispersed relatively, and give a reference isochron age of $T \approx 0.97 \pm 0.31$ (2 σ) Ga, $(^{143}\text{Nd}/^{144}\text{Nd})_i = 0.51106 \pm 28$ (2 σ). The Rb-Sr isochron age approximates to 819 Ma with $(^{87}\text{Sr}/^{86}\text{Sr})_i \approx 0.7118$. Obviously, the deposit was formed in the late Mesoproterozoic and ore-bearing intrusions were from an enriched mantle source. The ore-forming geological process is relative to the rifting and converging processes of the Rodinia.

Key words: isotopic age, isotopic geochemistry, Jinchuan copper-nickel ore deposit

Discussion on the Petrogenic Time of the Longshoushan Group, Gansu Province

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The Longshoushan Group is located in a narrow zone with a NW-SE direction in the Longshoushan area (Fig. 1), northwestern Gansu Province. It is suspected that it belongs to the Archean or Proterozoic since there are no precise and reliable isotopic data. Currently an accurate isotopic age of 2015 ± 16 Ma (Fig. 3) using the single-zircon U-Pb was obtained from trondjemite in the Longshoushan area. The location of sample D10 is in Shuangjizi, about 30 km northwest to Jinchang City; and the zircons that we have analyzed are selected from the gray deformed trondjemite in the so-called Longshoushan Group. After Fig. 4, the lower intersection age 452 ± 16 Ma stands for the thermal-tectonic event of collision in the Longshoushan area in the Caledonian; and the upper intersection age 2015 ± 16 Ma, reflects the petrogenic time of the trondjemite. The trondjemite might intrude the upper crustal rocks although it is adjacent to the rocks of the Longshoushan Group with fault. So the petrogenic time of the group should be more than 2015 Ma. Combined with Sm-Nd, Rb-Sr, other single-zircon U-Pb ages and regional geology correlation, we thought that the rocks of the Longshoushan Group mainly contributed to Paleoproterozoic. And these ages also implied that there was another important Precambrian thermal-tectonic event besides two main activities of 2500 and 1800 Ma in North China platform.

Key words: Gansu Province, Longshoushan Group, petrogenic time, single-zircon U-Pb age

K-Ar and ^{40}Ar - ^{39}Ar Ages of Pseudotachylites and Their Wall Rocks from the Eastern Dabie Mountains and Their Implications

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Pseudotachylites developed along the NE-SW trending faults in the eastern Dabie Mountains are a tectonite formed by ultracataclasis of rapid faulting, which is testified by the characteristics of its occurrence and microstructure, as well as lithochemistry. The bulk K-Ar ages of the pseudotachylites and their respective wall rocks from different localities yielded a narrow range of 81–93 Ma, and moreover, the laser probe $^{40}\text{Ar}/^{39}\text{Ar}$ dating of phengite overprinting the pseudotachylite gave a weighted mean age of 78.9 Ma. These results show that the pseudotachylites from the eastern Dabie Mountains formed along the NE-SW-trending fault zone during the uplifting of the orogenic belt at 80–90 Ma, which places important constraints on the cooling and exhumation history of the Dabie Mountains during and after the Late Cretaceous. Furthermore, the correspondence of the ages obtained from the above two different methods suggests that the bulk K-Ar dating technique is still an effective method to determine the age of some crushing-generated pseudotachylites and therefore the age of the pseudotachylite-bearing faults, especially for younger tectonic events.

Key words: eastern Dabie, pseudotachylite, bulk K-Ar age, laser probe $^{40}\text{Ar}/^{39}\text{Ar}$

Sedimentary Environments of Siliceous Rocks in the Western Yarlung Zangbo Suture Zone, Southern Tibet

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Siliceous rocks are widespread in the western Yarlung Zangbo suture zone, and assigned to the Cretaceous based on radiolarian fossils. Three principal lithologic associations have been recognized: (1) alternating pillow-basalt/siliceous rock association, (2) mélange chert association, and (3) clastic/chert association. Geochemically, siliceous rock element ratios of $Al/(Al+Fe+Mn)$, MnO/TiO_2 , and Ce/Ce^* anomaly reveal the sedimentary features. Siliceous rocks from the first association have ratios of $Al/(Al+Fe+Mn) = 0.533-0.546$ (<0.619), $Ce/Ce^* = 0.67$ (average), $(La/Yb)_n = 0.83-1.37$ and $(La/Ce)_n = 0.82-2.23$. Siliceous rocks from the mélange have ratios of $Al/(Al+Fe+Mn) = 0.557-0.619$ (<0.619), $Ce/Ce^* = 0.995-1.35$, $(La/Yb)_n = 0.71-1.03$ and $(La/Ce)_n = 0.68-0.985$. Cherts from the clastic/chert association of the Zongzhuo Formation have ratios of $Al/(Al+Fe+Mn) = 0.615-0.707$, $Ce/Ce^* = 0.94-1.14$, $(La/Yb)_n = 1.44-1.66$ and $(La/Ce)_n = 0.85-1.07$. In the $Al-Fe-Mn$ diagram the siliceous rock samples fall into the biogenesis field. A biogenesis of the three principal lithologic associations is suggested. Each association represents a distinct environment, i.e. alternating pillow basalt/chert association is deposited in an oceanic basin, clastic/chert turbidite graywacke-chert in a deep-water environment of continental margin, and mélange chert-shale in the transition belt between oceanic basin and continental margin in the western Yarlung Zangbo suture zone.

Key words: siliceous rock association, biogenesis, sedimentary environment, Yarlung Zangbo suture zone

Geochemical Studies on the Lower Cambrian Witherite-bearing Cherts in the Beidabashan

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The major elements, trace elements, silicon isotope, oxygen isotope, strontium isotope and neodymium isotope of witherite-bearing cherts have been studied in this paper. The results suggest that the ore-bearing siliceous rocks have an origin of the mixture of normal biochemistry and hydrothermal water sedimentation, and the sedimentary tectonic environments of the footwall siliceous rocks are different from those of the hanging wall siliceous rocks and overlying siliceous rocks. The footwall rocks are deposited near the vent of a basin that is controlled by the activity of growth fault, similarly to cherts deposited near the ridge of a modern ocean basin. The hanging wall siliceous rocks are deposited in a basin environment, with weak hydrothermal activity, and far away from the vent, similarly to cherts deposited in a modern ocean basin. The overlying siliceous rocks were not influenced by hydrothermal activity, and they are deposited on the margin of a hydrothermal basin. The witherite orebodies are deposited in the peak stage when the basin spread strongly, and

the witherite orebodies spatially formed in "reef-silicon formation" which is characterized by an overlap of endogenetic activity (bioactivity) and exogenetic activity (volcanic or hydrothermal activity). So, siliceous country rocks of the orebodies record a complete history of hydrothermal activity, and witherite deposits are strongly related to the hydrothermal activity in basin.

Key words: Beidabashan, witherite deposit, cherts, geochemistry

Vertical Distribution of the Tertiary Vitrinite Reflectivity (R_o) and Its Geological Significance in the Western Qaidam Basin

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The Mangya depression, located in the western Qaidam Basin, is one of the main oil-bearing units in the Qinghai oilfield. Two vertical distribution styles have been found after the study of the Tertiary vitrinite reflectivity (R_o). Firstly, a linear correlation between R_o and depth is conspicuous, and it is clear that such distinct relation exists in the center of the depression, which shows stability of the sedimentary environment, the sources of sediments and the structural activities. Secondly, it is found that thrusting and superposition are developed according to the dextral-stepped arrangement of R_o and the depth in the cross plots. What is more, by calculating the denuded stratum thickness in the work area with the method named $EASY\%R_o$, the main structure should occur along Ganchaigou-Youquanzi. However, the present landform shows that the main peak of the Yingxiongling is the ridge axis. This ostensible appearance can be well explained if we take the denudation in this area with a thickness of 3,600–3,750 m into account. It is also found that most of the oilfields distribute along denuded gradient zones. These results are important for the exploration and development of the Qaidam Basin.

Key words: R_o , $EASY\%R_o$, thermal evolution, thrusting and superposition, denudation

Composite Characteristics of Lake Facies Source Rock in the Shahejie Formation, Dongying Depression

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The Paleogene Shahejie Formation is the most important hydrocarbon accumulation combination in the Dongying depression. On the basis of former researches, the authors collected more than 600 source rock samples and 186 oil samples from 30 oil fields, and carried out organic geochemical testing. According to the combining sedimentary sequences and

geochemical analyses, the source rock of the Shahejie Formation can be divided into three genetic models, including saline lake facies (the upper Sha-4), semi-saline deep lake facies (the lower Sha-3) and fresh lake facies (the middle Sha-3), corresponding to under-filled, balance-filled and over-filled lacustrine types respectively. Furthermore, there is intense heterogeneity in the source rock of the Shahejie Formation, particularly in the balance-filling process. This heterogeneity is closely related to the change of lake level. According to this relationship, the authors proposed fluctuating lake-facies sedimentation. Oil-source correlation shows that source rocks from saline and semi-saline lake facies are the main source rock in the Dongying depression. Finally, the authors discussed the occurrence of organic matter and the manner of petroleum migration, and pointed out that oil generating from saline lake facies source rock migrated laterally and accumulated on the margin of the basin, but oil from semi-saline lake facies source rock migrated vertically and accumulated around the center of the basin.

Key words: Source rock, combination characteristics, fluctuating lake-facies sedimentation, heterogeneity, Dongying depression

Magnetic Fabric Characteristics of Flooded Sediments in the Middle Reaches of the Yangtze River

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Flooded sediments provide important material for studying the scale and law of ancient flood disaster events in the middle-lower reaches of the Yangtze River. Through systematical sampling, measuring and calculating the sediments of the dam break, occurring in Paizhouwan of Hubei Province in August 1, 1998, identification marks of magnetic fabric characteristics of the modern dam-break flooded sediments in the middle reaches of the Yangtze River are established and discussed in this paper. The magnetic fabric characteristics of the dam-break fan sediments are as follows. From the foot to the edge of the dam-break fan, the statistical average values of the magnetic fabric parameters (anisotropy degree of magnetic susceptibility P , magnetic facet F , magnetic lineation L and velocity of water flow FS) all change from large to small. The statistical directions to the principal axis of the magnetic susceptibility magnitude ellipsoid in different positions of the dam-break fan have different features, that is, the statistical direction changes greatly at the foot and the edge of dam-break fan. Especially, at the edge of the dam-break fan the direction of the maximum susceptibility principal axis is at random with no obvious main direction, but it is relatively stable in the middle of the fan. And the optimum direction of the maximum axis is very clear.

Key words: middle reaches of the Yangtze River, Paizhouwan dam-break fan sediments, magnetic fabric characteristics