13α(*n*-alkyl)-tricyclic terpanes: A series of biomarkers for the unique microbial mat ecosystem in the middle Mesoproterozoic (1.45~1.30Gyr) North China Sea

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Anoxygenic photosynthesis may have modulated Proterozoic oxygen production and sustained an intermediate redox state in the oceans for the Earth's middle age [1, 2]. A special biomarker assembly indicates that a unique prokaryotic microbial mat ecosystem may have contributed to the major primary production in the middle Mesoproterozoic (1.45~1.30Gyr) North China sea [3]. However, we know little about the microbial structures of the Mesoproterozoic microbial mats. Here, we report for the first time that the series of 13α(n-alkyl)-tricyclic terpanes (C_{18}~C_{33}) (13αNATTs) occurs in the organic-rich shales from this middle Mesoproterozoic sequence, including Hongshuizhuang Fm, Tieling Fm and Xiamaling Fm. We infer the long straight-chain substitution (up to C_{15}) in 13αNATTs to be originally of n-alkyl-substituted chain, while not of demethylated isoprenoid chain [4]. This scenario is probably just like that of hopanes. Thus, 13αNATTs may have originated from prokaryotes, given the robust evidence of steranes being undetectable in the shales [3].

The fact that 13αNATTs have not been detected from the post-Mesoproterozoic sedimentary sequences in China, may suggest that 13αNATTs could be a unique series of biomarkers for some special Mesoproterozoic prokaryotes, which probably disappeared from the late geological record. The remaining key question is to reveal what kinds of prokaryotes may have contributed to 13αNATTs?

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Phase equilibrium of the Cd-bearing quaternary reciprocal system at 298 K

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Solid-Liquid Equilibrium of reciprocal quaternary system K^+, Cd^{2+}//Cl^-, SO_4^{2-}-H_2O at 298 K were studied by an isothermal solution saturation method. Experimental results indicate that there are seven univariant curves F_2E_2, F_4E_2, E_2E_1, F_3E_1, E_1E_3, F_5E_3, F_1E_3, three invariant point: : E_1, E_2 and E_3 and five crystallization fields in the reciprocal quaternary system. There is double salt $Cd_3KCl_7{\cdot}4H_2O$ existing in the reciprocal quaternary system. The crystallization zones of equilibrium solid phases are K_2SO_4 ($F_2E_2F_4$), KCl ($F_4E_2E_1F_3$), $CdCl_2{\cdot}H_2O$ ($F_5E_3F_1$), $Cd_3KCl_7{\cdot}4H_2O$ ($F_3E_1E_3F_5$), $3CdSO_4{\cdot}8H_2O$ ($F_1E_3E_1E_2F_2$), respectively. The point E_1 represents the equilibrium of three solid phase KCl, $Cd_3KCl_7{\cdot}4H_2O$, and $3CdSO_4{\cdot}8H_2O$. The eutectic point E_2 represents the equilibrium of three solid phase K_2SO_4, KCl and $3CdSO_4{\cdot}8H_2O$. The other eutectic point E_3 represents the equilibrium of three solid phase $Cd_3KCl_7{\cdot}4H_2O$, $CdCl_2{\cdot}H_2O$ and $3CdSO_4{\cdot}8H_2O$. Potassium Sulfate has the biggest crystallization fieldwhile Cadmium Chlorine has a smaller crystallization region than others.