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Pitfalls in interpreting hydrocarbon charge timing based on fluid inclusion analysis and calcite cement U-Pb geochronology

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Direct dating hydrocarbon charge timing in petroliferous basins is vital for reconstructing the evolution history of petroleum reservoirs and de-risking petroleum exploration. In situ carbonate U-Pb dating combined with fluid inclusion analysis offers a new approach to constrain hydrocarbon charge timing and has been widely applied to determine hydrocarbon charge events. However, a common pitfall in interpreting U-Pb geochronology of carbonate cement in the published literatures is the confusion of carbonate cementation age with hydrocarbon charge timing (event). Considering multiple fluid flow events could occur temporally and spatially in a basin, discrete U-Pb ages obtained in carbonate cements that contain hydrocarbon inclusions or bitumen may not necessarily represent the true hydrocarbon charge age. To constrain a hydrocarbon charge event, it is necessary to date at least two consecutive carbonate cement phases. Here we report the right procedure of determining hydrocarbon charge timing by integrating *in-situ* calcite U-Pb geochronology, fluid inclusion microthermometry and fluorescence spectroscopy. We have delineated one significant hydrocarbon charge event in an Ordovician deeply-buried carbonate reservoir in the Tarim Basin, western China by dating successive carbonate cementation events within a single facture-filling calcite vein. The calcite vein recorded five generations of calcite precipitation spanning over 37 million years (from ~353 Ma to ~316 Ma). The oil charge event was constraint to have occurred around 336.34 Ma to 328.80 Ma between the third and fourth cementation events. A procedure for directly dating hydrocarbon charge event using *in-situ* calcite U-Pb geochronology and fluid inclusion analysis is proposed.