Hf-W 同位素体系研究意义及现状简述

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行星的形成与分异的时标和机理可以用短寿命放射性同位素体系量化。^{182}Hf 经 β^-衰变为 ^{182}W，其半衰期为 8.90±0.09Ma [1]，属于典型的短寿命放射性核素。利用该同位素体系，可用于限制行星和星子的增积、金属相与硅酸盐相分异时间(如核形成)及可应用于研究地球、月球等早期演化及核形成时间。近年来，许多学者利用 Hf-W 同位素体系做了如下研究：1) 太阳系的起源和它的早期增生与分异[2-3]；2) 月球的年龄和起源[4-6]；3) 行星(如地球、火星)的分异和核的形成[2,5,7-8]；4) 地球和月球的早期演化[4,9-10]；5) 陨石年龄和成因[11-12]。这些已得到的成果为探索地球、月球及太阳系内其他星体的起源和演化提供了重要资料。

^{182}Hf-^{182}W 同位素体系作为强有力的计时器，具有明显的优势。首先，根据动力学原理可推断 ^{182}Hf-^{182}W 同位素体系半衰期与类地行星增积时间范围在同一时标内[13]，因此，相对于 Al-Mg 同位素体系(半衰期=0.73 Ma)更有广泛的应用。另外，Hf、W 均为难熔元素，被认为在球粒陨石中的组成与太阳系一致。由此能得出一个合理的假设：地球、火星及小行星带具有相近的母体/子体比值；其次，Hf 的强亲石性和 W 的适中亲铁性，使得它们在核形成过程会发生强烈的分异。此外，太阳系初始的 ^{182}Hf 丰度较高，由它衰变而成的 ^{182}W 也因此会较高，能够满足开展 Hf-W 同位素体系研究所需要的分析要求。

由于 W 具有很高的第一电离能(～7.98eV), 用热电离质谱(TIMS)分析其电离效率及精度都很低，直到负热电离质谱(NTIMS)[11,14-15] 和多接收电感耦合等离子体质谱(MC-ICPMS)[16-19]的出现并应用到 W 同位素测试，才推动了 Hf-W 同位素体系的研究发展。在我国，对 W 同位素的研究相对较少，且分析时所需消解样品量大，实验流程过长，造成珍贵样品的浪费和试剂的使用量过大，为了改进 W 同位素的分析方法，仍需要做更多的研究。

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