学校编码：10384

学号：22420091151126

厦门大学

硕 士 学 位 论 文

西北冰洋和南极普里兹湾及其邻近海域镭同位素的示踪研究

Radium isotopes in the western Arctic Ocean and the Prydz Bay and its Adjacent Areas, Antarctic

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专业名称：海洋化学

答辩日期：2012年6月

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摘 要

226Ra、228Ra是研究海水运动的理想示踪剂。由于半衰期的不同，它们被广泛应用于不同区域、不同时间尺度的海洋学过程研究。本文以226Ra、228Ra为示踪剂，揭示了西北冰洋和南极普里兹湾及其邻近海域水团组成、水体运移、水体混合和停留时间等信息。

西北冰洋226Ra、228Ra的含量和分布受白令海入流水、东西伯利亚沿岸水、冰融水、河水、海底沉积物和波弗特流涡等多种因素的影响。受白令海入流水东、西侧不同海流的影响，楚科奇海陆架区东、西两侧的水体存在明显差异，西侧水体的226Ra含量较高而228Ra含量较低，东侧水体228Ra含量较高而226Ra含量较低。根据226Ra、228Ra和228Ra/226Ra)A.R.的上述特征，发现楚科奇海陆架区的两种水体由于运移路径的不同，在 加拿大海盆北部海域的不同位置会观测到两者同时存在于不同深度或者只有单一水团存在的情况。楚科奇海东、西侧陆架水的228Ra/226Ra)A.R.与河水组分份额之间具有良好的线性正相关关系，而加拿大海盆北部海域水体的228Ra/226Ra)A.R.落在拟合线下方，反映出水体由楚科奇海陆架运移到加拿大海盆北部海域过程中228Ra的衰变损失，根据陆架水与海盆水228Ra/226Ra)A.R.与河水组分份额之关系的差异，计算出加拿大海盆北部表层水体中河水组分的平均停留时间为5.7~11.2 a。阿尔法海岭附近海域表层水的228Ra比活度明显低于报道的穿极流表层水的228Ra高值，说明穿极流已经偏离阿尔法-门捷列夫海岭，由228Ra/226Ra)A.R.计算出加拿大海盆北部B84B和B85站水体的垂直涡动扩散系数分别为为0.73 cm2/s和0.41 cm2/s。加拿大海盆南部陆坡区水体的水平涡动扩散系数（Ky）为1.0×107 cm2/s。

在普里兹湾及其邻近海域，表层水226Ra、228Ra比活度和228Ra/226Ra)A.R.呈现由湾顶向湾外降低的趋势。在陆坡区，Ra含量由表层至近底层呈增加的趋势，反映出海底沉积物对Ra的补充，但在埃默里冰架前缘海域，海底沉积物对Ra的贡献较少，导致226Ra比活度随深度的变化不大，而228Ra比活度则随着深度的增加而降低。根据S-226Ra示踪体系计算出研究海域各构成水体的贡献和分布，其中冰融水受南极风场作用的影响，呈现由湾内向湾外增加的趋势，在普里兹湾东侧海域出现最

大值，且此区域的南极夏季表层水份额最低，普里兹湾中深层水的份额最高。埃默里冰架前缘表层水的温度、盐度、228Ra比活度、228Ra/226Ra)A.R.自东向西逐渐降低，验证了埃默里冰架前沿海流“东进、西出”的运移路径，根据228Ra/226Ra)A.R.与冰融水份额fI（%）的关系，计算出水体自进入埃默里冰架至其流出所经历的时间为7.5~8.0 a。由228Ra比活度与冰融水份额fI（%）在研究海域不同位置的差异，揭示出绕极深层水涌升的位置可能在普里兹湾外67°S以北、73°E以西海域，该区域最有可能形成南极底层水。

关键词：镭同位素；水体运动；西北冰洋；普里兹湾

Abstract

Due to their different half-lives, radium isotopes, 226Ra and 228Ra, have been successfully used as tracers for water mass and movement with different time scales. In this study, 226Ra and 228Ra datas from the western Arctic Ocean, the Prydz Bay and its adjacent areas of the Antarctic Ocean were present. The distribution of 226Ra and 228Ra provided useful information on the water masses, water transport and mixing, the residence time in the Arctic Ocean and the Prydz Bay and its adjacent areas.

Spatial distribution of 226Ra and 228Ra in the western Arctic Ocean was affected by the Bering Sea Water, the East Siberian Coastal Water, ice-melt water, river water, the seabed sediments, the Beaufort Gyre and so on. Affected by the northward flow of the Bering Sea waters, there were two distinct water masses in the Chukchi shelf. High 226Ra and low 228Ra activity concentrations occurred in the west of Chukchi shelf, while high 228Ra and low 226Ra in the east. With the different pathways to the basin, two water masses were found at different depths at the same location or different locations in the northern Canada Basin. A good positive linear relationship was observed between 228Ra/226Ra)A.R. and the fractions of river runoff for Chukchi shelf waters, while the 228Ra/226Ra)A.R. in the northern Canada Basin was located below the regressive line. The low 228Ra/226Ra)A.R. in the northern Canada Basin was ascribed to 228Ra decay during the shelf waters transporting to the deep basin. The residence times of 5.7~11.2 a were estimated for the river waters in the northern Canada Basin. The surface 228Ra activity concentrations in the Alpha-Mendeleyev Ridge were lower than those reported in the Transport Drift, suggesting that the pathway of the Transport Drift has been shifted. The vertical eddy diffusion coefficients at station B84B and B85 in the northern Canada Basin were estimated by 228Ra/226Ra)A.R. as 0.73 cm2/s and 0.41 cm2/s, respectively. The horizontal eddy diffusion coefficients (Ky) in the continental slope regions of the southern Canada Basin was 1.0×107 cm2/s.

In the Prydz Bay and its adjacent areas of the Antarctic Ocean, surface 226Ra and 228Ra activity concentrations, and 228Ra/226Ra)A.R. were all gradually increased from the open ocean to inshore. Radium isotopes concentrations increased with the increasing depth in the continental slope region, suggesting the Ra input from the seabed sediments. However, in the front of Amery Ice Shelf, 226Ra had a uniform concentration, while 228Ra activity concentrations decreased with the increasing depth, indicating a little input from the seabed sediments. Based on the relationship between 226Ra and salinity, three water masses were identified in the study sea areas. From the deep ocean to inshore the ice melted water (IMW) fractions increase, with the maximum fraction occur in the eastern Prydz Bay, corresponding to the minimum fraction of the Antarctic Summer Surface Water (AASSW) and the maximum fraction of the Prydz Bay Deep Water (PDW). The surface temperature, salinity, 228Ra activity concentrations and 228Ra/226Ra)A.R. decreased from east to west along the front of Amery Ice Shelf, testifying the major flow into the ice shelf occurs at the eastern end and exits from the west. The elapsed times of water masses under the Amery Ice Shelf were estimated as 7.5~8.0 a based on the relation between the 228Ra/226Ra)A.R. and the IMW fractions fI (%). The relationship between 228Ra activity concentrations and fI(%) was different in the west part and the east part of the Prydz Bay, indicating the upwelling of the Circumpolar Deep Water was most probably in the north of 67°S and the west of 73°E.

Keywords: Radium isotopes; water transport and mixing; the western Arctic Ocean; the Prydz Bay and adjacent areas

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