A New Monitoring Tool for Assessing Environmental Impact of Offshore Drilling Activities: Benthic Foraminifera

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Résumé en anglais	Since 2003 we have tested the use of benthic foraminiferal faunas as bio-indicators of highly biodegradable oil-based drill fluids and cuttings. In this paper we present data for 4 sites off western Africa (Angola, Congo and Gabon), with water depths varying from 30 to 670 m. A very similar faunal response to environmental perturbation is found in these different environmental settings. In the close vicinity of the oil drill mud and fluids disposal, the combination of lowered bottom water oxygenation, the presence of toxic compounds and a general ecosystem enrichment leads to strongly impoverished faunas. More sensitive taxa become very rare in these areas. Moderately impacted sites are characterized by high to very faunal densities, and a strong dominance of opportunistic taxa, that are favored by the increased amount of organic matter in the benthic environment, resulting from the introduction of hydrocarbons. Beyond 500 m of the disposal sites, the faunas progressively become similar to the natural faunas; the relative frequency of opportunistic and stress-tolerant taxa drops to background values.Two foraminiferal indices are proposed that allow a quantitative evaluation of the impact of the oil drilling activities. A first foraminiferal index, that is based on the cumulative percentage of opportunistic and stress-tolerant taxa, is very effective in continental shelf settings. Severely polluted sites contain more than 70% index species, moderately impacted area between 50 and 70%. In slightly to non impacted sites, the percentage of index species drops from 50 to 20%. A shallow, 30 m deep, area in front of the Ogooué estuary reveals a high percentage of marker species at all investigated stations. This elevated percentage is caused by the presence of naturally eutrophicated conditions due to the supply of important amounts of nutrients and continental organic matter by river outflow. In this a particular setting, oil exploration activities appear to have only a minor environmental impact. At the 670 m deep upper slope site, the impacted stations are characterized by the progressive disappearance of the taxa that are most sensitive to ecosystem perturbation. The cumulative percentage of these taxa strongly decreases at the most impacted areas, which provides a very useful additional quantitative monitoring tool. The present data show that foraminiferal faunas are extremely powerful in monitoring the environmental impact of oil exploration activities. In the near future, the proposed foraminiferal indices will be tested in other areas, and the selected marker species will be formalized for different types of environmental settings, with different water depths and climatic conditions.
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