# Measurement of $^{226}$Ra using a RaDeCC and its application for tracing submarine groundwater discharge

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A delayed coincidence counter (RaDeCC), which previously had been developed to determine ultra-low levels of $^{223}$Ra and $^{224}$Ra in seawater (Moore and Arnold, 1996), was used in a new way to measure $^{226}$Ra. Using a high speed Ra extraction system, Ra was pre-concentrated from a large volume of seawater (> 100 L) onto $MnO_2$-coated fibre. After the measurement of $^{223}$Ra and $^{224}$Ra with the RaDeCC, we show in this study that the $^{226}$Ra activity in the same sample can be successfully determined using the RaDeCC's ability to record alpha decay of its daughters as total counts. In order to have enough ingrowth time of $^{222}$Rn, the column containing the $MnO_2$-fiber is hermetically sealed for a few days. The ingrown $^{222}$Rn is circulated through the RaDeCC air-loop system for ten minutes followed by shutting down of the pump and closure of the scintillation cell. Counting may be completed within a few hours for $^{226}$Ra in normal seawaters. With a standard calibration, the results from this method were in good agreement with the data obtained from another verified method using a radon-in-air monitor (RAD-7). In addition to this development, we present $^{226}$Ra data from Gamak Bay (South Sea of Korea), which has been acquired with the new RaDeCC method. A mass balance model for $^{226}$Ra in the bay reveals that the input of SGD in the shallow area (< 5 m water depth) was about 1.2-1.9 × $10^7$ $m^3$ $day^{-1}$ in spring and summer 2006, which was two orders of magnitude higher than the total stream discharge (0.27~0.30 × $10^5$ $m^3$ $d^{-1}$) during the study period.

## References

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# No matrix-like rims on CR chondrules

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In the past it was widely held that chondrules are surrounded by compact matrix-like rims that formed in the solar nebula [1]; the most dramatic evidence was presented by Metzler *et al.* [2] for rims on CM chondrules. These thick rims are envisioned to have formed one grain at a time [3]. However, simulations and physical modelling show that the accretion of small (≤1 μm) grains produces structures with high porosities of >80%, far higher than observed (~14%) in the fine matrix of chondrites or in the purported matrix-like rims [4]. Trigo-Rodriguez *et al.* [5] presented evidence and arguments supporting the alternative interpretation, that CM matrix (~35 vol%) was compacted by asteroidal impacts rather than in the nebula, and that the rims surrounding most chondrules were the result of enhanced compaction near incompressible objects such as chondrules. In BSE images these compacted "rims" are darker than surrounding matrix.

A problem with studying matrix in CM chondrites is that they have experienced extensive aqueous alteration. On the other hand, in some primitive chondrites of type 3.0 or 3.1 that have experienced little aqueous alteration there is very little matrix making its chemical study and the petrographic comparison of matrix and possible rims very difficult. We have therefore focused our study on the CR chondrites, which have large amounts (~32 vol%) of matrix and large intact chondrules but have experienced much less aqueous alteration than CM chondrites. In our section of CR LAP02342 most chondrules show no textural evidence of being surrounded by rims. Potential rims are small in thickness and irregular.

Models of the formation of radially symmetric rims in the nebula require them to form one grain at a time [3] and thus be compositionally homogeneous. We have surveyed random spots in the matrix and compared them to regions near chondrules (i.e., possible rims). There is a relatively large degree of variation in matrix composition, and this carries over to the rims as well. In some cases matrix on opposite sides of a chondrule showed resolvable differences in composition, inconsistent with symmetric formation. If rim formation was not occurring at the CR-chondrite formation locations, it is unlikely that rims formed around chondrules at other locations.

## References

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