A SYSTEMATIC INVESTIGATION ON THE EFFECTS OF THE MAJOR
CHEMICAL AND CHEMICAL-PHYSICAL PARAMETERS ON Cs AND Sr
DISTRIBUTION COEFFICIENTS IN A FRESH WATER SAMPLE.

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INTRODUCTION

The aim of this work was at determining the distribution coeffi
cients (Kd, cm^3/g) of Cs and Sr and the evaluation in a fresh water
sample of the major chemical and chemical-physical parameters that
effect them.

There are lots of Kds in the literature which have been deter-
mined in different samples (sediments, soil, clay, silt, sand and
synthetic materials), with different analitycal procedures and method.
Obviously, these results should not be undiscriminatingly used in
radionuclide transport studies using mathematical models to predict
the environmental impact of conventional and non-conventional dis-
charges.

It is quite simple to think or imagine that many variables
or parameters may change the Kd values so that it could be extremely
useful to investigate and understand this phenomenon.

It is obvious that the best sample for the investigation is a
real sample. At the same time the investigating procedure should not
interfere with the natural equilibria involved.

Experiments were carried out on a fresh water sample gathered
from river Po making use of scintillation counting as the analytical
method.

EXPERIMENTAL

Special care was taken in the collection, transportation and
conservation of the water sample.

Because about twenty days were necessary for the lab-investi-
gation, the stability of the sample was considered fundamental.

The sample, after the collection, was characterized from the
chemical, mineralogical and granulometric viewpoints.

The stability, during the lab-activity was checked following
granulometric distribution, some chemical parameters and the Kd
values. The results were satisfactory so that all the Kds can be con
sidered reliable.

^{137}Cs and ^{85}Sr were employed as radioactive indicators added to
the 250 ml homogeneus samples in a quantity less than the natural
concentration ($\simeq$ 0.015 ppb and 300 ppb respectively) just not to
modify the natural equilibrium.

After addition the polyethylene capped bottles were positioned horizontally on a mechanical shaker in controlled temperature. Shaking frequency was 70÷90 cycle/minute.

On the basis of preliminary kinetic investigations the time necessary for reaching the equilibrium conditions was 3h and 30' for Cs and 8h for Sr.

The analytical determination was made with the scintillation counting technique in the soluble phase, obtained through a 0.45 μm Millipore filter.

All the procedure mentioned above was set up previously and when it was ready we made the research reported in this paper so that it will be easy to repeat the experiments and to compare the results.

The major parameters affecting Kd values and the related interactions between them was found out in a preliminary work in which we employed a factorial ANOVA (analysis of variance) model.

Kd values were determined in triplicate by batch procedure in polyethylene sealed bottles in controlled temperature.

The distribution coefficient was calculated from:

$$Kd = \frac{\dfrac{A_o - A_f}{P}}{A_f - B} \cdot 10^6$$

where A_o is the initial activity, A_f is the final activity in the water phase (< 0.45 um), P is the particulate load (mg/l), and B is the blank activity.

The parameters investigated were:

for Cs: carrier - on the untreated sample and on the separated granu lometric fractions - temperature, pH and interaction pH-car rier, particulate load, granulometric fractions, TOC, clay concentration, UV radiations, freezing.

for Sr: effect of pH, temperature, carrier and related interactions, granulometric fractions, TOC, clay concentration, UV radiations.

RESULTS

The results of Kd were elaborated with ANOVA in order to find out the main effects and their interactions.

For Cs, effects: particulate, carrier, temperature and pH; interactions: pH-carrier and temperature-carrier.

For Sr, effects: particulate, temperature, carrier and pH; interactions: pH-concentration.

The relative residual variance, interpreted as an estimate of the general process error, is about 10%.

For Cs, Fig. 1 shows some typical dependence of Kd on the main factors: pH, temperature, Q_T (total amount of Cs in nano equivalents/l), P (particulate load mg/l), and in the following table some analytical dependence functions are shown.

TABLE

For Cs	For Sr
$Kd = 1.15 \cdot 10^4 \cdot Q_T^{(-0.408)}$	$Kd = 4.78 \cdot 10^4 \cdot P^{(-0.89)}$
$Kd = 2.45 \cdot 10^4 \cdot P^{(-0.230)}$	$Kd = 6.59 \cdot 10^3 \cdot d_m^{(-1.076)}$

where Q_T = total concentration of the element in nano equivalents/l

P = particulate load in mg/l

d_m = mean diameter of particulate fractions in μm.

The other results will be reported in the final paper. Also kinetic results are available for Cs absorption obtained with a proper equipment set up for the purpose.

COMMENTS

Considering the results obtained, the procedure adopted is re-commended. At the same time as it is not complicated, it could be improved and standardized if the need for reliable Kds is considered necessary. Moreover, other interesting elements could be investigated.

Such activity is under way in our laboratories.

At the same time, because of the fact that a great quantity of Kds are available, coming from different samples and analytical pro-cedures, we distinguish them as "natural", "isotopic", "mass" and "from leaching". This distinction is necessary for understanding the phenomena and for using Kd more correctly.

Fig. 1