

Separation of rare earths on anion-exchange resins

III. The position of scandium in the separation scheme of rare earth complexes with ethylenediaminetetraacetic acid*

According to a proposition of VICKERY the term "Rare Earths" should include all elements of the III A group whose electronic 5 *d* shell is empty or incomplete, *i.e.* "Rare Earths" = lanthanides + Y + Sc. In fact, the similarity of the chemical properties of these elements and the geochemical associations justify this definition.

Small amounts of scandium occur in practically all lanthanide minerals and will be, at least partly, precipitated with lanthanide oxalates². In previous papers^{3,4} we showed that lanthanides and yttrium can be separated in the form of their complexes with ethylenediaminetetraacetic acid (H₄Y) by anion-exchange chromatography. The separation factors were promising and the method is now being tried out as a tool in activation analysis of the rare earths. In connection with this work the elution behaviour of scandium in the system: Amberlite IRA-400 [H₂Y²⁻]-Na₂H₂Y aq. had to be checked. The method of investigation and apparatus were essentially the same as described earlier⁴, except that a jacketed column was used and a temperature of 25 ± 0.2° was maintained throughout the experiment. The distribution coefficients λ_{Sc} were calculated from elution curves using the equation:

$$\lambda_{\text{Sc}} = \frac{U_{\text{max}} - (U_0 + V)}{m}$$

where: U_{max} = the effluent volume when the concentration of scandium reaches its maximum, U_0 = dead volume of the column, V = free volume of the resin bed, and m = mass of the dry resin in the column. Making use of the relation:

$$\frac{d \lg \lambda_{\text{Sc}}}{d \lg [\text{H}_2\text{Y}^{2-}]} = -\frac{\nu}{2}$$

the charge, ν , of the complex ion was shown to be -1, *i.e.* the same as those of lanthanides, in agreement with data given in the literature⁵. In 0.01 *M* Na₂H₂Y solution λ_{Sc} = 17, and the separation factor with respect to europium:

$$\alpha_{\text{Eu}}^{\text{Sc}} = \frac{\lambda_{\text{Sc}}}{\lambda_{\text{Eu}}} = 0.0291.$$

Comparing this with the data of Table I (ref.⁴) it can be seen that scandium will be eluted between thulium and erbium in close vicinity to the former. A typical elution curve of scandium in the presence of lutetium and yttrium is shown in Fig. 1. Thus, the order of elution of the complete rare earth group is: Lu, Yb, Tm ≅ Sc, Er, Y, Ho, La, Dy, Ce, Tb, Pr, Nd, Gd, Pm, Sm, Eu. Because of the similarity of the distribution

* For Part II, see *J. Chromatog.*, 7 (1962) 98.

coefficients of Sc and Tm as well as of their long half-lives, it is doubtful whether these elements can be determined separately by radioactivation and anion-exchange chromatography in $\text{Na}_2\text{H}_2\text{Y}$ solution.

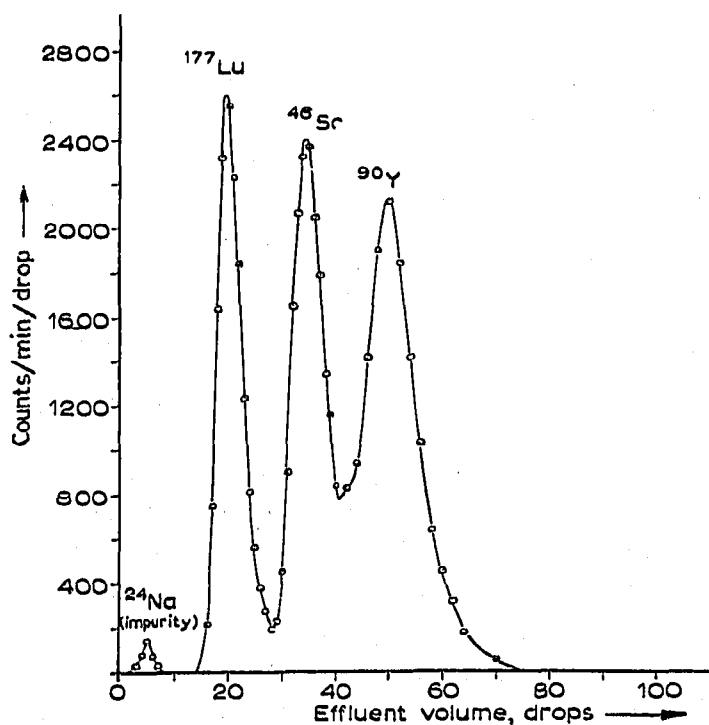


Fig. 1. Separation of Lu, Sc, and Y tracers. Column: $4.00 \text{ cm} \times 0.0360 \text{ cm}^2$, Amberlite IRA-400 $[\text{H}_2\text{Y}^{2-}]$ (particle size $10\text{--}35 \mu$). Eluent: $0.008 \text{ M Na}_2\text{H}_2\text{Y}$; $\text{pH} = 4.60$. Flow rate: $1.1 \text{ ml.sq.cm}^{-1} \text{ min}^{-1}$.

Keeping in mind the correlation⁴ between the distribution coefficients of the rare earths in the Amberlite IRA-400 $[\text{H}_2\text{Y}^{2-}]$ - $\text{Na}_2\text{H}_2\text{Y}$ aq. system and the solubilities of the NaLnY type salts, it may be assumed that the solubility of the NaScY salt will be higher than that of NaErY and close to that of NaTmY .

Analytical Chemistry Division, Institute of Nuclear Research,
Polish Academy of Sciences, Warsaw (Poland)

JERZY MINCZEWSKI
RAJMUND DYBCZYŃSKI

¹ R. C. VICKERY, *Chem. & Ind. (London)*, (1954) 761.

² R. C. VICKERY, *Chemistry of the Lanthanons*, Butterworths Sci. Publ., London, 1953.

R. C. VICKERY, *Analytical Chemistry of the Rare Earths*, Pergamon Press, London and New York, 1960.

³ R. DYBCZYŃSKI, *Mitteilungsblatt der Chemischen Gesellschaft in der D.D.R.*, Sonderheft 1960, *Analytische Chemie*, p. 393-401.

⁴ J. MINCZEWSKI AND R. DYBCZYŃSKI, *Chem. Anal. (Warsaw)*, 6 (1961) 275; *J. Chromatog.*, 7 (1962) 98.

⁵ F. NELSON, R. A. DAY, JR. AND K. A. KRAUS, *J. Inorg. & Nuclear Chem.*, 15 (1960) 140.

Received September 6th, 1961

J. Chromatog., 7 (1962) 568-569