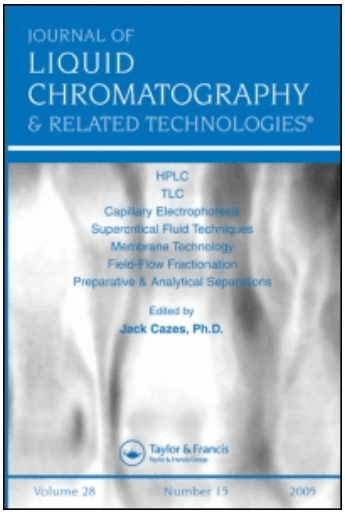

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Chromatographic Behavior of 43 Cations on Silica Gel G in Acetone-Formic Acid Systems

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CHROMATOGRAPHIC BEHAVIOR OF 43 CATIONS ON SILICA GEL G IN ACETONE-FORMIC ACID SYSTEMS

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ABSTRACT

A systematic study of the chromatographic behavior or 43 metal ions has been carried out in Acetone-Formic Acid systems on thin layers of Silical Gel G. The separation potential of these systems has been investigated for numerous metal ions and a number of useful and interesting separations have been predicted. The results obtained have been discussed and analysed.

INTRODUCTION

Thin layer chromatography is an efficient technique for the separation of metal ions. Recent work done up to 1972 has been admirably summarized by Brinkman[1]. The systematic study of quantitative separations of metal ions has been carried out by Qureshi and Thakur[2,3] and they have also studied the effect of various factors such as sample concentrations, eluent concentrations, pH and ionic strength. All these studies suffer from the following limitations.

- -The absorption behavior of elements has not been examined in detail.
- -The effect of non-aqueous media on absorption of elements has not been studied systematically.

Kraus and Nelson[4] have investigated the absorption of the elements by Dowex 1-X10 from hydrochloric acid. But the literature survey showed that such studies have not been carried out on silica gel. In continuation of our previous papers[2,3], the present work was therefore undertaken to remove these limitations. The chromatographic behavior of 43 metal ions was investigated, using acetone and formic acid in various ratios. Acetone was used because it does not solvate the ions and because it suppresses hydrolysis to give more compact spots.

EXPERIMENTAL

Apparatus: Thin layer chromatography apparatus (Toshniwal, India) for the preparation of silica gel plates on 20 x 3.5 cm glass plates. The chromatography was performed in 24 x 6 cm glass jars.

Reagents: Silica gel G (E. Merck), formic acid (B.D.H.), acetone (B.D.H.) of AnalaR grade were used. All other reagents were of the same grade as used in our previous papers[2,3].

Test Solutions: The procedure for the preparation of test solutions of metal ions was the same as used in our previous papers[2,3].

Detection: The metal ions on silica gel plates were detected by the same respective reagents as used in our previous papers[2,3].

Preparation of Silica Gel Plates: A slurry was prepared by mixing the silica gel with constant shaking for 5 minutes in conductivity water in the ration of 1:3. This slurry was used immediately to coat the clean glass plates with the help of the applicator to give a layer of 0.25 mm thickness for qualitative studies. Firstly, these plates were dried at room temperature and then in an electrically controlled oven at 100 ± 5°C for 2 hours for complete drying and then stored in an oven at room temperature until they were used.

Procedure: Approximately 3 µl of the test solutions (0.1M) were applied on each silica gel plate using a micropipette. The solvent was allowed to ascent 10 cms from the starting line on the plate in all cases. After the development was completed, the plates were dried in the air oven and the cations were detected with the usual reagents.

RESULTS AND DISCUSSION

The chromatographic behavior of 43 metal ions was studies in different ratios of acetone and formic acid (10:0, 9:1, 7:3). The results are summarized in Figures 1, 2, and 3.

The following important separations are possible in acetone and formic acid media as shown in Figures 1, 2, and 3.

A. Acetone-Formic Acid (9:1):

1. Separation of As^{5+} and Sb^{5+} from Pb^{2+}, Ag^{+}, Th^{4+}, Zr^{4+}, Ta^{5+}, Mo^{6+}, and W^{6+}.
2. Separation Ta^{5+} and Nb^{5+} from Ti^{4+}, Pt^{4+}, Fe^{3+}, Au^{3+}, As^{5+} Sb^{5+}, and Uo_2^{2+}.
3. Separation of Mo^{6+} and W^{6+} from Ti^{4+}, Pt^{4+}, Fe^{3+}, Au^{3+}, As^{5+}, Sb^{5+}, and Uo_2^{2+}.
4. Separation Uo_2^{2+} from Th^{4+}.

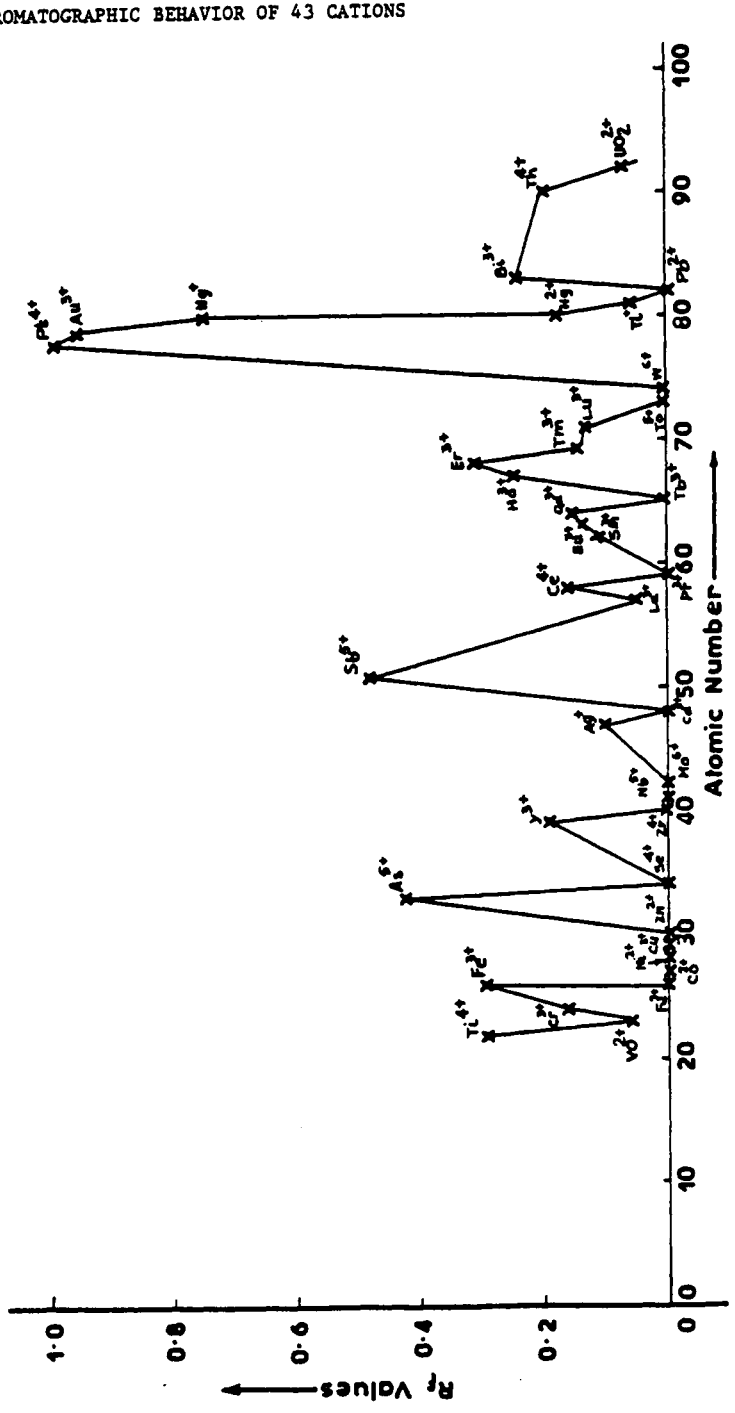

Figure 1 : Chromatographic behaviour of 40 metal ions in Acetone–Formic acid (10:0) system.

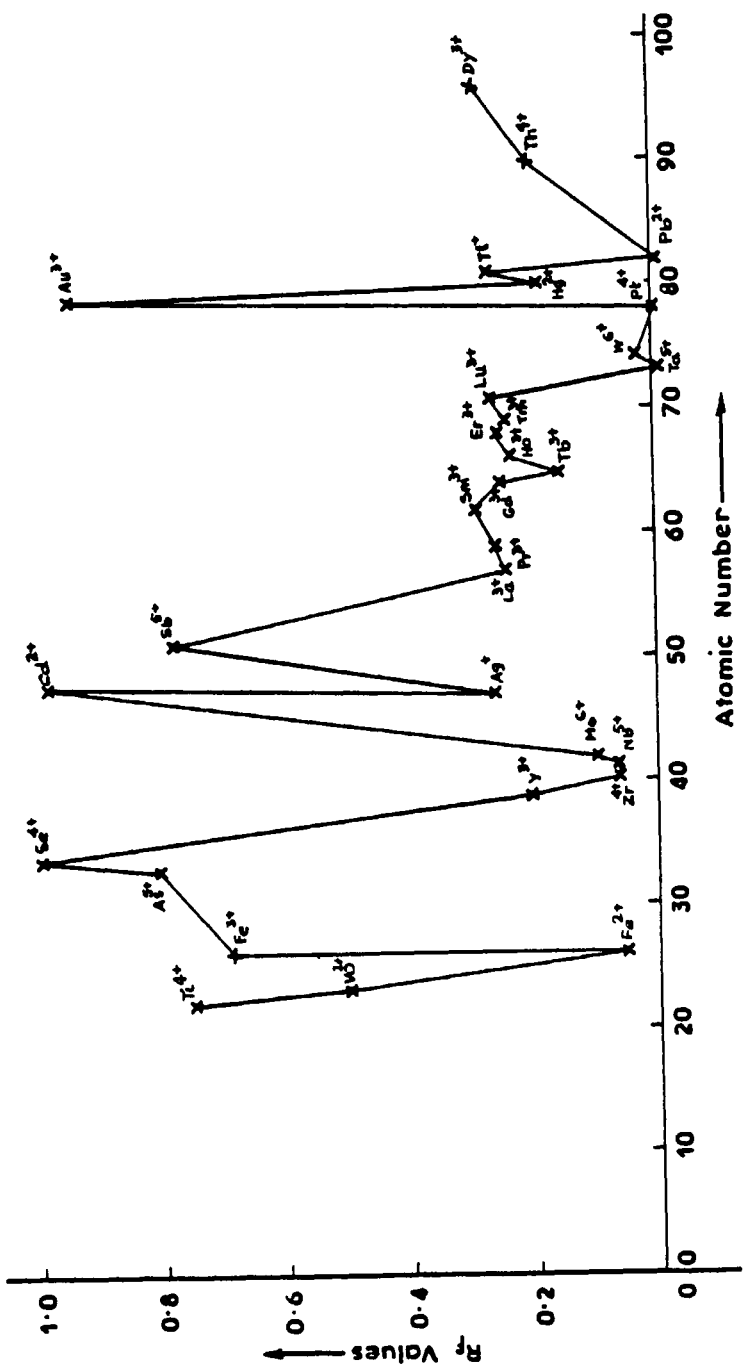

Figure 2: Chromatographic behaviour of 31 metal ions in Acetone–Formic acid (9:1) system.

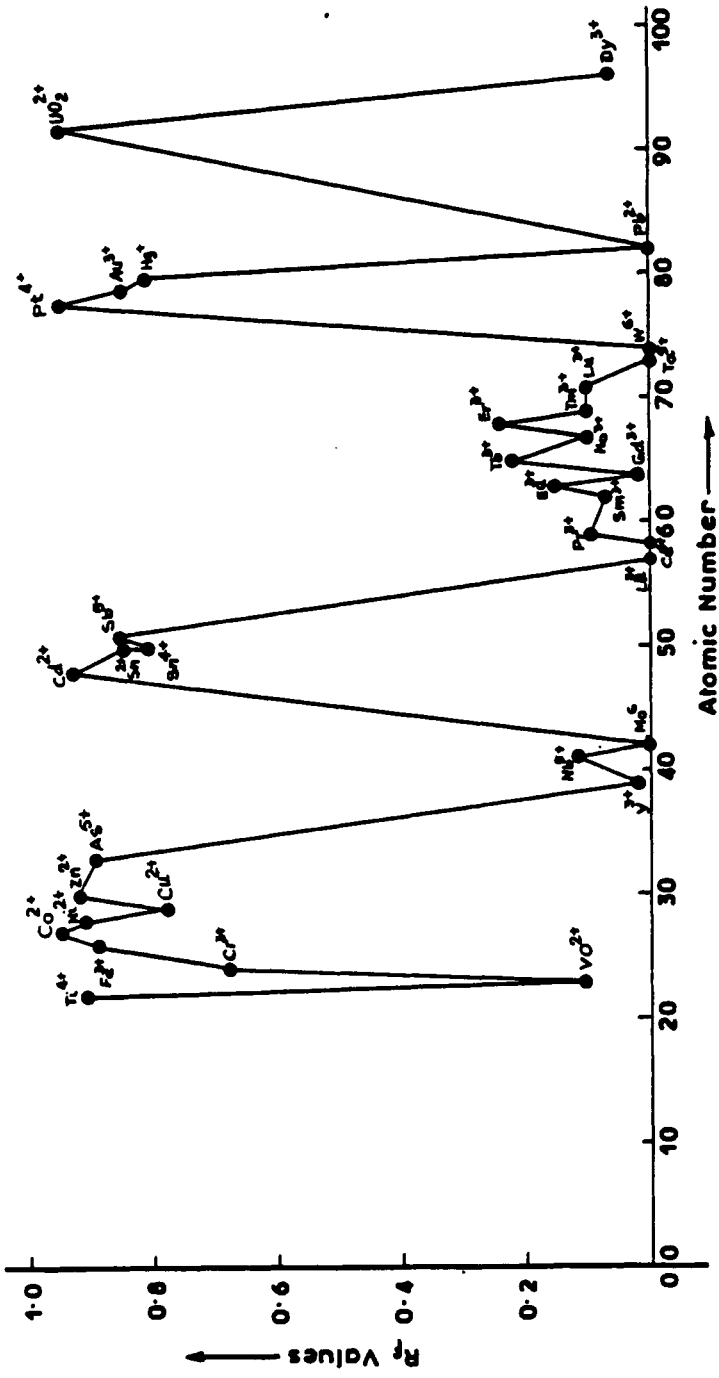

Figure 3: Chromatographic behaviour of 34 metal ions in Acetone–Formic acid (7:3) system.

B. Acetone-Formic Acid (7:3):

1. Separation of Pb^{2+} from numerous metal ions.
2. Separation of Ta^{5+}, Nb^{5+}, Mo^{6+}, and W^{6+} from numerous metal ions.
3. Separation of Uo_2^{2+} from VO^{2+}.

C. Acetone-Formic Acid (10:0):

1. Separation of Hg^{+}, Pt^{4+}, and Au^{3+} from numerous metal ions.

Those metal ions form strong complexes with the formate ions have high R_f values in comparison to other metal ions which form weaker anionic complexes. As the concentration of formic acid was increased, the metal ion had to compete with the formate ions to the exchange site, hence this metal ion has a high R_f value. Since silica acts as a weak cation exchanger (see equation 1) the anionic formatocomplex is not absorbed, leading to high R_f.

$$2m\ (\equiv Si\text{-}OH) + m\ Cd^{2+} \rightleftharpoons m(\equiv Si\text{-}O)_2\ Cd^{2+} + 2m\ H^{+} \qquad (1)$$

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