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A comparison of some ready-for-use thin layers for the separation of heavy metals with butanol–3 *N* HCl

We have recently proposed a simple scheme for identifying substances by means of thin-layer chromatography by chromatographing with one (suitably chosen) solvent on several ready-for-use thin layers (usually four or five) thus obtaining more data with various supports than are obtained (evidently) with one single chromatogram. We were impressed by the fact that rather good identification was possible with some alkaloids and dyestuffs as well as with amphetamines[1,2].

An obvious extension of this work was to investigate how inorganic ions would behave on various thin layers. It was soon realized that interaction with various supports can not compete with varying the solvent composition *e.g.* the group Fe(III)–Co(II)–Ni(II) cannot be separated at low hydrochloric acid concentrations, whatever the support, while at high hydrochloric acid concentrations many other metals are difficult to resolve. However, this first survey yielded a number of interesting results concerning the behaviour of heavy metal ions in a typical partition solvent (butanol–3 *N* HCl) on a wide range of ready-for-use thin layers.

Experimental

The following thin layers were unsuitable for chromatography of heavy metal ions with butanol–3 *N* HCl: All thin layers on aluminium foil (which reduces some metals such as Au(III) and Hg(II)), several silica gel layers and alumina layers gave trouble with uneven solvent flow or poor spots. Similarly polyamide 6 (MN) and acetylated cellulose layers were abandoned after preliminary trials. Good chromatograms were obtained on various celluloses, ion-exchange celluloses and on polyamide 11 layers. The chromatograms with 19 of the common heavy metals are summarized in Fig. 1.

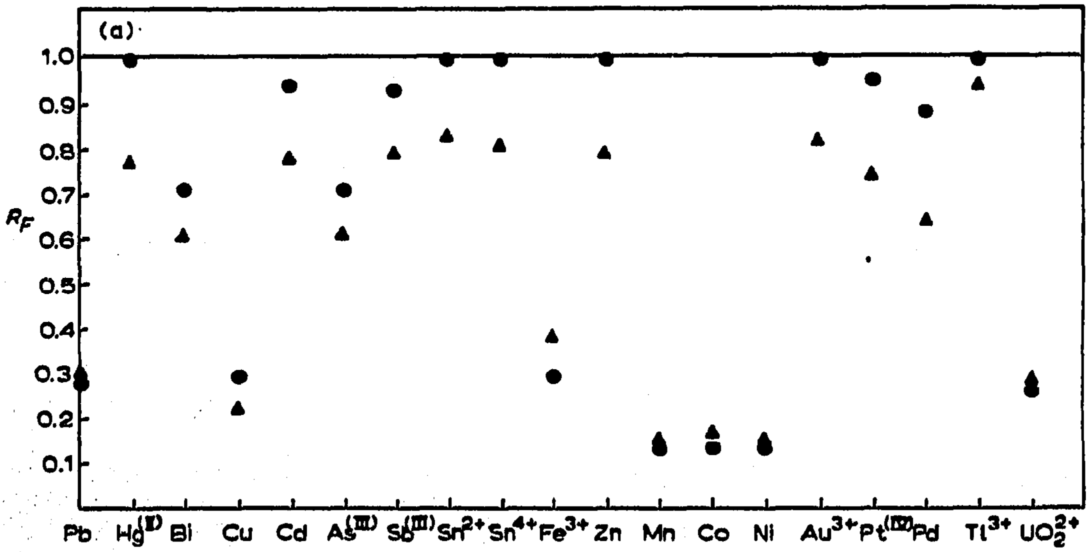

Fig. 1

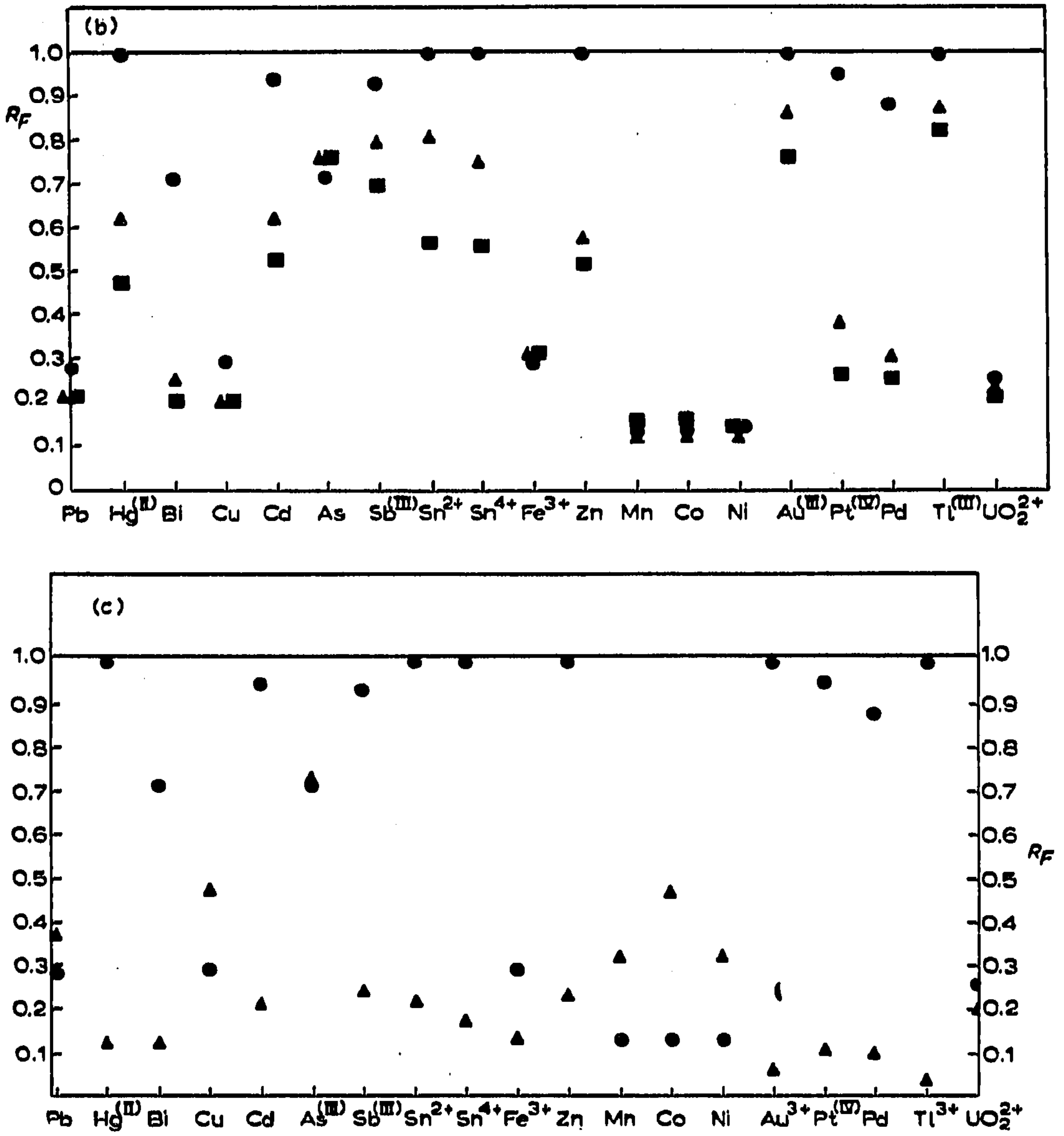

Fig. 1. (a) Schematic representation of the R_F values of heavy metals on cellulose and carboxymethyl cellulose layers. Technique: Ascending development in glass tanks lined with filter paper saturated with the mobile phase; thin layers: MN-Polygram Cel 400 and MN-Polygram Cel 300 CM; solvent: butanol–3 *N* HCl. ●, Cel 400 and ▲, Cel 300 CM. (b) Schematic representation of the R_F values of heavy metals on cellulose and anion-exchange cellulose layers. Technique: as in Fig. 1a; thin layers: MN-Polygram Cel 400, MN-Polygram Cel 300 DEAE and MN-Polygram Cel 300 Ecteola; solvent: butanol–3 *N* HCl. ●, Cel 400; ▲, DEAE and ■, Ecteola. (c) Schematic respresentation of the R_F values of heavy metals on cellulose and polyamide layers. Technique: as in Fig. 1a; thin layers: MN-Polygram Cel 400 and MN-Polygram Polyamid 11; solvent: butanol–3 *N* HCl. ●, Cel 400 and ▲, Polyamid 11.

Results

Carboxymethyl cellulose (Fig. 1a) yields consistently lower R_F values for fast moving spots and the same R_F values for slow moving spots. The lowering can be explained by the higher polarity of the stationary phase leading to a different distribution of butanol, water and hydrochloric acid between the support and the moving solvent.

Anion-exchange celluloses (Fig. 1b), *i.e.* DEAE-cellulose and Ecteola–cellulose show that here partition + ion exchange can take place and can alter several separation sequences. Ecteola–cellulose gives usually lower R_F values than DEAE–cellulose. Large R_F differences between cellulose and ion-exchange celluloses exist notably for Bi(III), Zn(II), Pt(IV) and Pd(II).

On polyamide 11 layers there is essentially an inversion of the sequence found on cellulose (Fig. 1c) Those metal ions which on cellulose travel on the solvent front are found around R_F 0.2 on polyamide 11 and the slow moving metal ions (on cellulose) are considerably faster on polyamide 11 (such as Mn, Co, Ni) but not well separated from each other.

It is clear that whatever the stationary phase in this case may be, it is less polar than the mobile phase. A similar behaviour was already noted on highly-acetylated cellulose papers[3] with butanol–HCl mixtures. However, polyamide 11 seems to have better properties for general analytical work and we are planning to investigate their properties in more detail in the near future.

Conclusions

A survey of commercial ready-for-use thin layers for their suitability in separating heavy metals with butanol–3 *N* HCl showed that anion-exchange celluloses can combine partition with anion exchange and polyamide 11 layers invert the usual sequence of R_F values. A number of other thin layers were found unsuitable for the separation of metal ions with partition solvents.

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