

CHROM. 8283

## Note

### Elution sequence as a function of temperature in the gas-liquid chromatography of monoterpene hydrocarbons

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(Received February 5th, 1975)

The chromatographic behaviour of the main monoterpene hydrocarbons in essential oils has been investigated and, in attempts to find the best conditions for their quantitative assay, these compounds were examined by gas-liquid chromatography (GLC) on different columns at different column temperatures. It was noticed that the Kováts retention indices ( $I$ ) behaved in a different manner for the aliphatic and the alicyclic hydrocarbons when the temperature of the GLC column was changed. This effect was particularly evident when polyethyleneglycol was used as the stationary phase.

The influence of temperature on the retention parameters has been reported earlier<sup>1-5</sup> and effects on terpenoid compounds have been observed by Roberts<sup>6</sup> and Andersen and Falcone<sup>7</sup>.

The variation of  $I$  values with temperature ( $T$ ) can be used to distinguish between different chemical groups in a complex mixture such as essential oils. The  $\Delta I/\Delta T$  values may also give a clue as to the identity of a compound. When capillary gas chromatography is applied to the analysis of terpene mixtures, the  $\Delta I/\Delta T$  value gives additional information on the compounds. We have investigated several essential oils<sup>8</sup> and the identities of myrcene, *cis*- $\beta$ -ocimene and *trans*- $\beta$ -ocimene in the hydrocarbon fraction could well be indicated by this method.

Compounds that belong to other groups, e.g., oxygenated terpenes, can be identified satisfactorily by the procedure described here. 1,8-Cineol, a compound that very often elutes together with the hydrocarbon fraction in a normal column separation of the essential oil<sup>9</sup>, is identified by its  $\Delta I/\Delta T$  value.

A typical series of analyses is shown in Fig. 1. The monoterpene hydrocarbon fraction of the essential oil of *Juniperus communis* L. spiked with 1,8-cineol and *trans*- $\beta$ -ocimene was analyzed at four different temperatures. 1,8-Cineol (peak 23), myrcene (8) and *trans*- $\beta$ -ocimene (18) change positions in the sequence of peaks and will thereby be indicated as compounds belonging to different chemical groups.

If the temperature at which such a group of compounds is analyzed is chosen at random, the total separation may be greatly influenced. We therefore would like

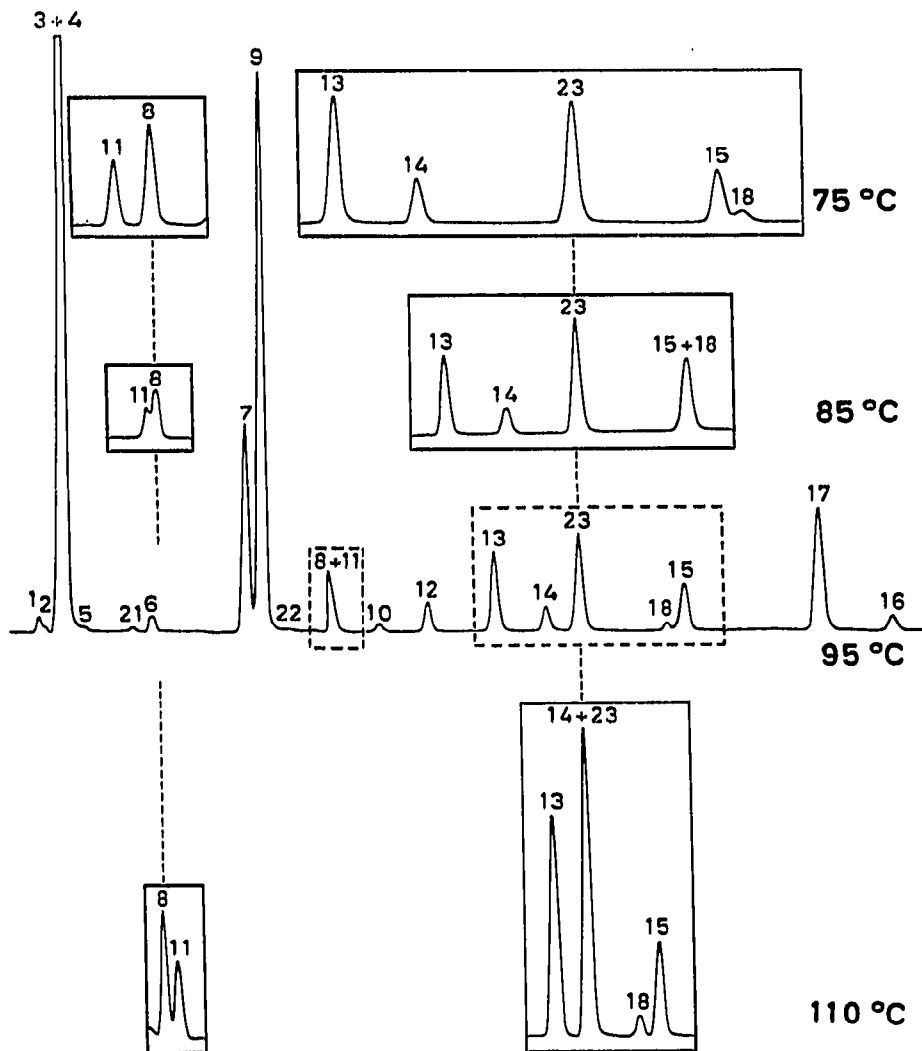


Fig. 1. Chromatograms of a terpene mixture obtained on a PEG 1540 column at 75°, 85°, 95° and 110°. Peaks: 1, tricyclene; 2, unidentified; 3,  $\beta$ -pinene; 4,  $\alpha$ -thujene; 5, unidentified; 6, camphene; 7,  $\beta$ -pinene; 8, myrcene; 9, sabinene; 10,  $\alpha$ -phellandrene; 11,  $\beta$ -carene; 12,  $\alpha$ -terpinene; 13, limonene; 14,  $\beta$ -phellandrene; 15,  $\gamma$ -terpinene; 16, terpinolene; 17, *p*-cymene; 18, *trans*- $\beta$ -ocimene; 21,  $\alpha$ -fenchene; 22,  $\Delta_4$ -carene; 23, 1,8-cineol.

to stress the importance of using different column temperatures when complex mixtures are to be analyzed, as this technique increases the information given by GLC analysis.

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