stances. (Similarly, Fig. 2 illustrates the emergence of the methyl esters of stearic and palmitic acids as a single peak.)

Although our attention has been focused on applications of this chromatographic procedure to separation of mixtures of fatty acids, there would appear to be no reason to believe that it could not be applied to other classes of compounds that contain no functional groups of sufficient polarity to eclipse the absorption-affinity contribution of vicinal pairs of bromine substituents.

These preliminary observations are published in the belief that the technique holds considerable promise as a means of sampling saturated, mono-unsaturated, and di-unsaturated fatty acids obtained from quite small amounts of naturally occurring lipids. We are currently engaged in such applications and in studies of the chromatographic behavior of fatty acid esters obtained by bromination of more highly unsaturated substances and of those containing isolated single bromine substituents in addition to vicinal pairs of bromine substituents.

### References and Notes

1. D. R. Howton, R. H. Davis, J. C. Nevenzel, *J. Am. Chem. Soc.* **76**, 4970 (1954).
2. This paper is based on work performed under contract AT-04-1-GEN-12 between the U.S. Atomic Energy Commission and the University of California at Los Angeles.
3. M. F. White and J. B. Brown, *J. Am. Chem. Soc.* **70**, 4269 (1948); S. F. Herb, L. P. Witnauer, R. W. Riemenschneider, *J. Am. Oil Chemists' Soc.* **28**, 505 (1951) and earlier publications.

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# *Communications*

## More on Induction of Tooth Defects by Thermal Shock

The communication by D. G. and H. A. Pohl [*Science* **120**, 807 (1954)] is interesting, but it appears to be based on several assumptions that do not appear valid from either clinical or histological viewpoints.

The first generalized assumption of "changed eating habits" carries with it the statement of present-day exposure of the teeth to extremes of temperatures and consequent probable induction of small cracks. Clinical observations clearly demonstrate that the anterior teeth are shielded by the lips when food or beverage of extreme temperatures are placed in the mouth. Complaints by patients of thermal sensitivity usually indicate a latent period of 10 to 15 sec. Extensive experience in clinical dentistry has clearly shown me that cracks of the dental enamel, when present in children or young adults, are the result of direct trauma; in the aged, they are found in the anterior teeth when the occlusion is of an end-to-end relationship. In the latter, roentgenograms will also disclose narrowing of the pulp chambers and canals, which probably indicates diminishing metabolic activity.

The second assumption, that the tooth enamel can be compared to the physical properties of "vitreous materials," is not sound. A glass or bone china dish is of homogeneous structure, whereas the dental enamel is a complex organ. In youth, and throughout life, remnants of an outer protein covering (primary surface cuticle) ensheath the millions of enamel rods that are closely intertwined in the cuspal areas. Each rod is encased by an organic sheath [D. B. Scott *et al.*, *J. Dental Research* **31**, 74 (1952)] and cemented to the adjacent rods by dense interprismatic material. To suggest that there is an implied validity in equating the smashing action of a weight on a dried extracted tooth (it is not stated whether the specimens are single or multirooted teeth) lying horizontally on a concrete floor with the normal occlusal forces on cusps or incisal edges of the teeth suspended by an elastic periodontal membrane in an alveolar socket is open to criticism.

Since the basis for the entire experiment is the hypothesis that cracks induced by thermal shock "furnish entrance sites for bacterial decay," one should expect a greater incidence of dental decay on the labial surfaces of incisor teeth that are more susceptible to such thermal shocks. All statistical evidence relative to the incidence of dental decay points to the immunity of the lower anterior teeth and of the labial surfaces of the upper anterior teeth.

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9 March 1955.

Although we feel that our communication was only a brief preliminary to necessary extensive work, and was, therefore, undeserving of any extended analyses, we feel that certain misunderstandings evident in Kamrin's comments may require clarification.

We agree wholeheartedly with Kamrin that further and more conclusive work needs to be carried out to show the fallacy or true extent of the indication in the data that thermal shock can damage teeth. If the inference is proved true, then a cure or abatement of the damage needs to be found.

Kamrin appears to imply that direct blows are the only cause of cracks in dental enamel. Have other causes, such as thermal shock, been generally recognized?

In regard to his comments about comparison of the resistance of dental enamel and ceramic materials to thermal shock, we would recall that crystallinity generally plays a very minor role. Whether or not a hot drinking glass will crack if doused with cold water does not depend greatly upon the content of crystalline material in the glass. The development of cracks in materials by thermal shock is more a matter of temperature gradients, coefficients of thermal expansion, internal strains, and strengths of materials. Incidently, glass or bone china are not strictly homogeneous structures. For example, bone china may be comprised of about 50 percent of crystalline material and 50 percent of amorphous. Ordinary glass frequently contains some 0.1 to 1.0 percent of crystalline material.

Contrary to Kamrin's statement, we did not equate the smashing action of a weight to the normal biting action experienced by teeth. Our purpose, as is abundantly clear from the communication, was to find a test, of whatever character, that would distinguish between teeth bearing high or low levels of strains and cracks.

His comments on the statistics of caries incidence in various locations of the mouth are interesting and we agree that this type of information will help us in properly assessing the problem; provided one takes into account such factors as our normal tendency to flip bites of hot food from the front teeth to between the molars with the tongue.

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15 March 1955.

## Isomerization of β-Carotene with Sunlight

Zechmeister and his associates have studied the isomerization of β-carotene by various methods, including fusion, refluxing its solution, use of iodine catalysis, shaking its solution with hydrochloric acid, and insolation (exposure to sunshine in the absence of catalyst) (*1, 2*). They obtained, by insolation, besides 98-percent recovery of all-*trans* β-carotene, 1 percent each of neo-β-carotene-U and neo-β-carotene-B (*2*).

In my work (*3*), in addition to neo-β-carotene-U and neo-β-carotene-B, the formation of neo-β-carotene-E was confirmed. A solution of chromatographically pure β-carotene (16 mg) in hexane (150 ml) was placed in a Pyrex measuring flask irradiated with direct noontime sunlight for 1.5 hr, and then chromatographed on lime-Celite (2:1). The appearance of the developed chromatogram is described in Table 1.

Table 1. Appearance of developed chromatogram. The numbers in parentheses in column 3 are the light absorption maxima in millimicrons used to characterize the zone materials.

| Zone width (mm) | Zone color | Zone identification |
|---|---|---|
| 2 | Orange | Irreversible layer (heterogeneous) |
| 15 | Almost colorless | |
| 25 | Reddish orange | Neo-β-carotene-U (480, 450) |
| 5 | Almost colorless | |
| 62 | Dark orange | β-Carotene (486, 454) |
| 28 | Dark yellow | Neo-β-carotene-B (476, 444) |
| 2 | Almost colorless | |
| 12 | Pale reddish | Neo-β-carotene-E (480, 447) |

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### References and Notes

1. L. Zechmeister *et al.*, *Nature* **141**, 249 (1938) ; *Biochem. J. London* **32**, 1305 (1938) ; *Ber. deut. chem. Ges.* **72**, 1340 (1939) ; *J. Am. Chem. Soc.* **64**, 1856 (1942) ; *ibid.* **65**, 1528 (1943) ; *Arch. Biochem.* **5**, 107 (1944) ; *ibid.* **7**, 247 (1945).
2. L. Zechmeister and A. Polgar, *J. Am. Chem. Soc.* **66**, 137 (1944).
3. I wish to thank L. Zechmeister for his kind advice.

2 February 1955.

## Note on the Al and Si Positions in Ordered Na and K Feldspars

The condition of disorder among the Al and Si positions in Na and K feldspars is well known, and the degree of disorder is measurable (*1*). To date, x-ray analysis has not been successful in determining the Si and Al positions in the ordered minerals. However, it is theoretically possible to predict the structural positions of Al and Si in the ordered mineral and to substantiate the prediction by observations of certain features that are described here.

The ordered or lowest energy level for the mineral would be expressed on the atomic level by having the highest polarizing power cations (Si) form the largest number of bonds with the most polarizable anions (bonded to Al). This condition would be realized if one-third of the Si cations shared two of their four anions with two Al cations and shared the other two anions with two other Si cations; two-thirds of the Si cations would share anions with one Al cation and three Si cations. This association results in polymerized Si—O—Si—O—Si—O—Si—O chains alternating with (but bonded to) chains of Si—O—Al—O—Si—O—Al—O that pass through the feldspar so as to produce periodically uniform bond conditions. "Partially disordered" feldspars could have the same cation associations, but the periodic uniformity would be lacking. Disordered feldspars could have some Si cations sharing anions with three Al cations and other Si cations sharing anions with four Si cations. One Al sharing an anion with another Al is unlikely, as is evidenced by the lack of Al-Si disorder in anorthite (*2*).

If the orientation of the chains in the mineral could be determined, the ordered configuration of the Na and K feldspars would be known. Three possibilities are present: the chains may parallel either the *a*, the *b*, or the *c* crystallographic axis. Chains parallel to the *c*-axis are such that two Al, Si positions per unit cell are not included in the chains. These two positions are included if the chains spiral along their length, but such chains would not occur because this results in some improbable bond combinations, such as