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27 July 1962

## New High-Pressure Polymorph of Zinc Oxide

*Abstract*. Zinc oxide exists in a sodium chloride structure form in the 100-kilobar pressure range. The cell edge of the high-pressure form is 4.280 A, the theoretical density is 6.912, and the enthalpy of transition is 785 cal/mole.

Zinc oxide (zincite) has a slightly distorted hexagonal wurtzite structure, and Bragg and Darbyshire (*1*) have claimed, after electron diffraction of thin films, that it can also exist in a cubic modification with the sphalerite structure. From a qualitative consideration of the effects of high pressures on ionic radii, zinc oxide, if subjected to high pressures, should invert to a NaCl structure. This polymorphic transition would produce a primary change in coordination number from four in the wurtzite structure to six in the NaCl structure.

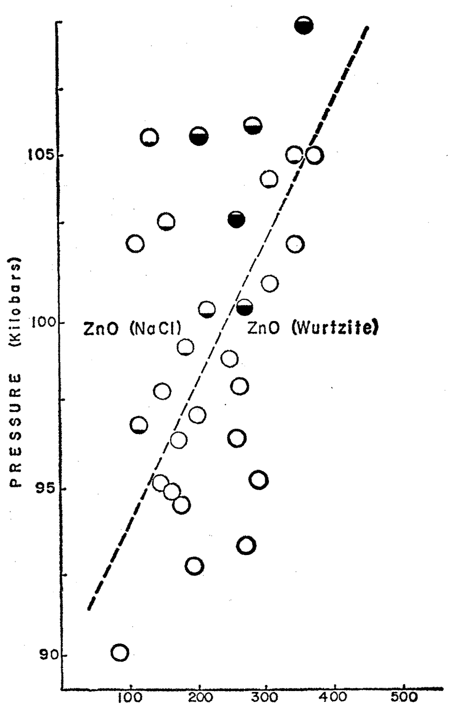


Fig. 1. Plot showing the *P-T* conditions for the formation of the NaCl form of ZnO. The dotted line is the approximate equilibrium curve.

We have synthesized a high-pressure polymorph of zinc oxide with the cubic NaCl structure.

The apparatus used and its accuracy, reproducibility, and limitations are essentially those described by Dachille and Roy (*2*), who used Bridgman (*3*) compound anvils. A Rene alloy anvil with a conical insert of grade 886 carboloy with 3/16-inch effective surface diameter was used for most of the runs. A small drop of saturated ammonium chloride solution was placed on the sample as a catalyst before the pelleted sample was covered with platinum–10-percent rhodium disks and placed between the anvils. The variation in recorded pressure during a single run was not more than ±6.5 kbar, as indicated on the Foxboro pressure controller.

In several runs above about 100 kbar a new form of ZnO appeared, and a univariant equilibrium curve between the two polymorphs based on such runs is presented in Fig. 1.

The new phase is identified and characterized by its x-ray powder pattern, which contains the distinctive reflections shown in Table 1. No higher angle peaks could be detected in a diffractometer pattern. The $a_o$ for the NaCl structure phase is 4.280 A, which gives a theoretical density of 6.912, whereas the density for the zincite structure is 5.680. Conversion could be effected only with ammonium chloride as a catalyst. Other substances, including distilled water and 0.1*N* sodium carbonate solution, produced no detectable conversion even at pressures well above the equilibrium curve. It would appear that the catalytic action of the ammonium chloride comes from formation of zinc-ammonia complexes. The rate of conversion appears to be very slow and usually a period of 36 to 48 hours is required to produce an appreciable amount of the new phase. Even with long runs the yield is only 30 percent. So far the new phase has not been prepared free from contamination by zincite.

The effect of shear on the phase transition was also studied, by the technique described by Dachille and Roy (*4*), but no conversion could be detected. However, with shear under pressures of about 100 kbar only short runs without catalyst could be made.

Table 1. Distinctive reflections in x-ray powder pattern of new zinc oxide phase.

| *hkl* | *d* (A) | $I/I_o$ |
|---|---|---|
| 111 | 2.479 | 60 |
| 200 | 2.140 | 100 |
| 222 | 1.5135 | 40 |

Sample extrusion and anvil failure under the high stresses produced were the controlling factors.

The high-pressure polymorph showed no tendency to revert to the wurtzite form even after it had stood for several weeks at room temperature. However, the high-pressure form does revert to the wurtzite structure at as low as 120°C (in 3 weeks). This may suggest that the inability to obtain the NaCl-phase pure may be due to failure of quenching.

The value of $dP/dT$ as obtained from the equilibrium curve gives a value of 42.5 atm/°C, yielding a $\Delta H$ of transition from the Clapeyron relation of 785 cal/mole at 25°C (*5*).

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5. This work was supported by the American Zinc Institute through a fellowship held by one of us (C.H.B.). This report is contribution No. 62-13 of the College of Mineral Industries, Pennsylvania State University.

2 August 1962

## A Gene in Drosophila That Produces a New Chromosomal Banding Pattern

*Abstract*. A change in the banding pattern of the distal end of the third chromosome in *Drosophila pseudoobscura* has been found. It appears to be produced by homozygosis for a recessive gene, which is called "salivary" (sal) in this report.

In the course of an experiment dealing with inversion polymorphism in *Drosophila pseudoobscura* (*1*), a new banding pattern, at the distal end of the third chromosome, was observed by one of us (L.L.) (Fig. 1). It was

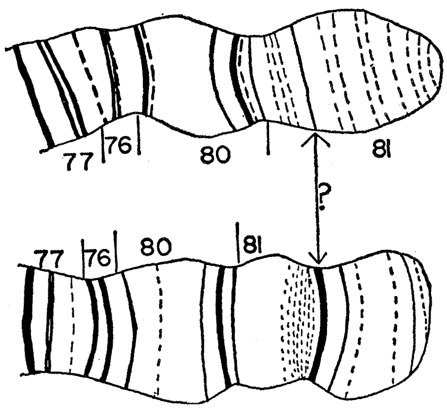


Fig. 1. Distal ends of unaltered (top) and altered (bottom) third chromosomes bearing the CH gene arrangements. The numbers refer to homologous sections (*5*). The arrow connects two bands which are presumed to be homologous. Immediately to the right of this band on the altered chromosome is the new or accentuated band of section 81.

found in the salivary gland preparations of a few individuals, all of which carried the Chiricahua (CH) gene arrangement in homozygous condition. The new chromosome was extracted from the population (W-11) by single-pair matings and progeny tests. A stock was formed in which all the third chromosomes were of the altered variety.

A striking feature of the altered chromosomal banding pattern is the introduction of a new or accentuated second heavy band near the middle of section 81. This is usually accompanied by a constriction in the chromosome at that point. This constriction causes the formation of an extra, intermediary bulge between the new (or accentuated) band of section 81 and the distal end of section 80. The appearance of the chromosome is unaffected by temperatures between 15° and 25°C. Measurements with an ocular micrometer of the length and width of sections 80 and 81 of 25 normal and 25 altered CH chromosomes showed that there is no significant difference between the chromosomal types in either length or width of these sections. Comparison of slides identically stained with the Feulgen reagent revealed no detectable difference in total staining.

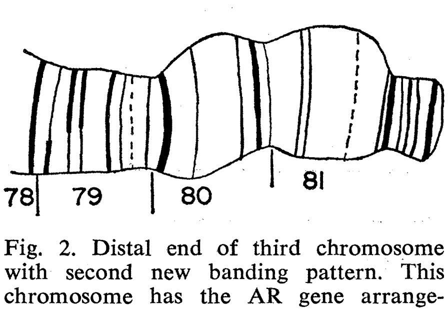


Fig. 2. Distal end of third chromosome with second new banding pattern. This chromosome has the AR gene arrangement.

The $F_2$ generation from the crosses of the altered stock with normal CH gave 72 normal and 26 altered karyotypes, suggesting a 3:1 ratio. A backcross of $F_1$ individuals to the altered stock gave 17 altered and 16 normal individuals, suggesting a 1:1 ratio. Crosses of the altered stock to individuals with normal chromosomes of the gene arrangements Chiricahua (CH) or Arrowhead (AR) gave all normal $F_1$ progeny (18 individuals). These breeding data strongly suggest the control of the chromosomal abnormality by a genetic unit that behaves as a single recessive gene which we call "salivary" (sal). This gene is probably located on the third chromosome, as shown by its failure to produce an altered chromosome in other than CH homokaryotypes in the population in which it was discovered. Since this gene has no known specific effects other than changing the chromosomal banding pattern, linkage tests cannot easily be made.

A single individual, in the same population from which sal was derived, was found to have another unique banding pattern in section 81 (Fig. 2). This pattern was observed in many cells of this gland, and occurred in an individual homozygous for the AR arrangement. The cause of this second abnormality is unknown, as it was not possible to obtain a stock of flies carrying this other abnormal chromosome. The absence of detectable structural heterozygotes in the population implies, as in the case of sal, that here again a chromosomal rearrangement is probably not involved.

To our knowledge, sal is the first gene found in *Drosophila* which causes a morphological change in a chromosome, other than the break caused by SD (*2*). Certain chromosomal rearrangements in *Chironomus* are however known to also cause changes in banding (*3*). In fact, to our knowledge, sal is the first gene known in any organism to produce a specific, single kind of viable chromosomal change. Experiments are now in progress testing the relative fitness of individuals carrying the altered CH as compared with those carrying the normal CH chromosome.

Until now a complex sequence of chromosomal rearrangements, such as is known to have occurred within *Drosophila pseudoobscura*, has been the only known mechanism for alteration of chromosome morphology. The discovery of sal suggests another mechanism, namely the establishment of genes that affect the chromosomal banding pattern itself. By the substitution of a single gene (sal), a banding pattern is produced which cannot be accurately homologized in every respect with that of the unaltered chromosome. Such a phenomenon could in part account for the evolutionary development of interspecific differences in chromosomal morphology (*4*).

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5 June 1962

## Determination of the Tropospheric Residence Time of Lead-210

*Abstract*. The ratios of bismuth-210 to lead-210 in rain samples were used to calculate tropospheric residence time for lead-210. The value of about 6 days thus obtained agrees closely with the average interval between two rainfalls.

In the past few years much work has been done on determining the mean residence time of matter in the troposphere and stratosphere. Tracers produced by nuclear bomb explosions have commonly been used in these studies. During the 1958–60 nuclear bomb test suspension period, while artificial radioactivity decayed to a low level, it was possible to measure natural radioactivity for such a study.

Radon isotopes, decay products of thorium and uranium in the earth's crust, escape from the crust into the