from mechanical mixtures containing known proportions of crystalline sodium silicates and quartz. Three to four percent quartz was readily detected. The magnitude of the leaching effect was thus estimated as being a 2 to 3 percent increase in silica content. A chemical analysis of the solid products of hydrothermal runs would not be meaningful; during the quenching step a hydrous glass was deposited around the crystalline products.

The hydrothermal runs were used only to fix the lower stability limit of the $Na_6Si_8O_{19}$ phase; this lower stability limit is unaffected by the presence of either excess $Na_2Si_2O_5$ or $SiO_2$.

These observations on the stability of the $Na_6Si_8O_{19}$ phase have been used to revise the phase diagram for the $Na_2Si_2O_5$–$SiO_2$ system (Fig. 2).

Differential thermal analysis of a crystalline $Na_6Si_8O_{19}$ sample shows no heat effects between room temperature and its melting point. The apparatus used could readily detect heat effects of 1 calorie per gram. There is, however, evidence that 72.7 percent $SiO_2$ glasses, devitrified at low temperature ($\sim$ 650°C or less), yield a metastable phase related to $Na_6Si_8O_{19}$ in structure and probably identical in composition.

The lower stability limit of the $Na_6Si_8O_{19}$ phase and its failure to persist metastably in the presence of $H_2O$, help explain why it has not been encountered in studies of the $Na_2O$–$SiO_2$–$H_2O$ system (*6*). Such studies have covered only the temperature range where $Na_6Si_8O_{19}$ is unstable. We have no explanation of Kracek's failure to encounter this phase, except that possibly he depended on optical identification of the phases present: the gross optical properties—morphology and birefringence—of $Na_2Si_2O_5$ and $Na_6Si_8O_{19}$ are similar.

J. Williamson
F. P. Glasser
*Department of Chemistry, University of Aberdeen, Old Aberdeen, Scotland*

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19 March 1965

## Specificity of Macroglobulin Antibody Synthesized by the Normal Human Fetus

Abstract. *The umbilical cord blood of 47 out of 54 normal human infants contains hemagglutinating activity directed toward cells coated with a type-L Bence-Jones protein. This hemagglutinating material, in some instances, is present in cord blood in the absence of such activity in the maternal blood. Ultracentrifugation of cord serum in a sucrose gradient shows that the activity is associated with the macroglobulin fractions.*

The normal human newborn has as its major circulating immunoglobulin $\gamma$G-globulin transferred from the mother's circulation (*1*). Since $\gamma$M-globulin apparently cannot be transferred across the placental barrier (*2*), the small amount of $\gamma$M-globulin present in the normal human fetus at birth is thought to be of fetal origin. There is no direct evidence for antenatal synthesis of $\gamma$G- or $\gamma$A-globulins under normal circumstances.

No antibody specificity has as yet been detected in the $\gamma$M-globulins of normal human newborn. I now report the presence of hemagglutinating activity in 47 of 54 serums obtained from the cord blood of apparently healthy human infants. Instances of the absence of such activity in the maternal serum when it is present in the infant strongly suggest the fetal origin of this circulating macroglobulin.

Serum from umbilical cord blood obtained at the time of delivery was examined together with the mother's serum obtained within 3 days thereafter. All mothers and their infants were entirely normal at the time of birth and in the immediate postpartum period.

Sheep erythrocytes treated with tannic acid were exposed to a solution of Bence-Jones protein (1 mg/ml), type L, isolated by gel-filtration chromatography from the urine of a patient having multiple myeloma (*3*). The protein solution was heated at 56°C for 15 minutes before being used for the coating procedure as described (*3*). The presence of protein as a cell coating was confirmed by agglutination of the cells in dilutions of rabbit antiserum to the L-polypeptide chain obtained from pooled normal $\gamma$G-globulins (*4*).

Dilutions (Fig. 1) of the paired cord and maternal serums were examined with the use of cells coated with Bence-Jones protein, type L, No. 46. In three instances no hemagglutinating activity was detected in either cord or maternal serum in 1:20 dilution. In 23 instances the $\log_2$ titer of the maternal serum was equal to or greater than that of the corresponding cord serum. In 28 instances the titer of the cord serum was greater than that of the corresponding maternal serum, and in 14 of these cord-maternal pairs no hemagglutinating activity was detected in the maternal serum when there was demonstrable activity in the cord serum. Hemagglutinating substances with specificity for cells coated with type-K Bence-Jones proteins have been detected in all the maternal serums but in only three cord serums.

Previous studies of adult-human serum having hemagglutinating activity for sheep erythrocytes coated with Bence-Jones proteins revealed that the active proteins reside in the macroglobulin fraction as measured in serum fractions obtained after ultracentrifuga-

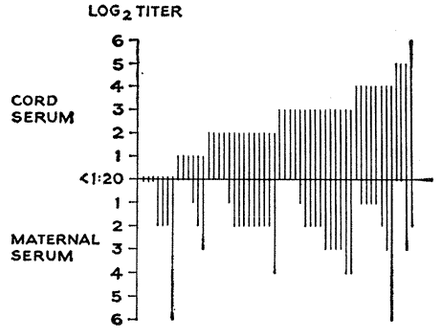


Fig. 1. $\log_2$ titers of umbilical cord serums and corresponding maternal serums expressed as bars above and below the initial 1-in-20 dilution. Cells coated with type-L Bence-Jones protein.

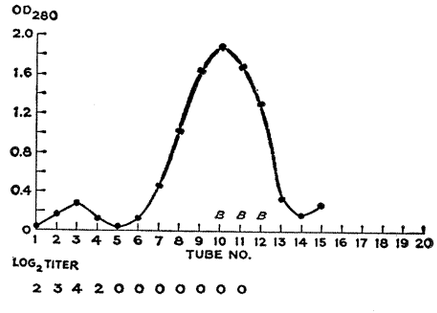


Fig. 2. Distribution of hemagglutinating activity in fractions obtained by centrifugation of cord serum No. 26 at 35,000 rev/min for 18 hours through a sucrose gradient. *B* designates fractions containing serum albumin.

tion in a sucrose gradient (*3*). Figure 2 shows the $\log_2$ titers of fractions of cord serum No. 26 obtained by ultracentrifugation in a continuous sucrose gradient (10 to 40 percent). The cells used were coated with Bence-Jones protein No. 46. All hemagglutinating activity was found in the heaviest protein fraction and none in fractions Nos. 8 to 10 in which $\gamma$G-globulin was concentrated.

The hemagglutinating characteristics of normal human cord blood for cells coated with Bence-Jones protein are the same as those previously described for normal adult serums (*3*). This latter activity has been categorized as being an expression of antibody. It is probable that the use of different Bence-Jones proteins as cell-coating substances will reveal hemagglutinating activity in most, if not all, healthy infants. The macroglobulin hemagglutinating substances found in normal cord blood are thought to be of fetal rather than maternal origin, as judged by the presence of such agglutinating activity in cord blood provided that it is absent or that it is present in a much smaller concentration in the mother's blood.

In the serum of adults, macroglobulin antibody to Bence-Jones protein is directed toward those L-chain sites which are relatively obstructed in intact $\gamma$-globulins by the adjacent H-polypeptide chain (*3*). In this study the agglutination system involving cord serum and cells coated with Bence-Jones protein, type L, No. 46, may be inhibited by the same Bence-Jones protein and by some but not all other type-L Bence-Jones proteins. Type-K Bence-Jones proteins and normal pooled $\gamma$G-globulin fail to inhibit under the same conditions. The agglutinating substances of cord serums with specificity for some type-L Bence-Jones proteins like those found in adult serums therefore appear directed toward a restricted portion of the L-polypeptide chain and are capable of distinguishing subtypes of type-L Bence-Jones proteins.

The specificity of the agglutinating activity of any cord serum for the free L-chain protein of that particular cord-maternal serum pair has not been established, because of limitations in the amount of individual cord and maternal serum available from which free L-chain protein may be isolated.

The specificity of this macroglobulin system directed toward the polypeptide chain common to all the immune globulins and its presence in healthy infants suggest a homeostatic function. One such function might be related to the regulation of the activity of those cells responsible for L-chain synthesis as they undergo antenatal differentiation. The exact nature of the antigenic stimulus for this antibody system in healthy adults and in the healthy human fetus remains to be delineated.

WALLACE V. EPSTEIN
*Rheumatic Disease Group, Department of Medicine, University of California, San Francisco Medical Center, San Francisco*

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## Sector Structure of the Quiet Interplanetary Magnetic Field

Abstract. *Observations of the interplanetary magnetic field by the Imp-1 satellite have revealed a regular longitudinal sector structure in this field. The sectors co-rotate with the sun; as an average sector sweeps past the earth the magnitude of the interplanetary field decreases from greater than 6 gammas (1 gamma = $10^{-5}$ gauss) to less than 4 gammas, and the daily sum of the geomagnetic activity index,* Kp, *decreases from 25 to less than 10.*

The average direction of the interplanetary magnetic field measured by the magnetometer experiment on the Imp-1 satellite (*1*) is consistent with the Archimedean spiral angle predicted by Parker (*2*). The radial motion of the solar wind stretches the solar magnetic field out away from the sun, and the solar rotation twists the field into a spiral such that at the earth the average angle between the interplanetary field direction and the earth-sun direction is about 45°. The angular distribution of the observed field directions shown in Fig. 1 is clearly peaked in approximately these directions. It is also usually possible to characterize the field direction at a given time as being predominantly either away from the sun or toward the sun.

We have shown (*1*) on this basis that the large-scale structure of the interplanetary magnetic field during three solar rotations has a recurrence period equal to the synodic rotation period of the equatorial region of the sun. This implies that the interplanetary field co-rotates with the sun (*3*).

The field direction during successive 3-hour intervals during the first three solar rotations observed by Imp-1 is shown by the + (away from sun) and − (toward the sun) signs at the circumference of Fig. 2. For a period of about 1 day centered about perigee the satellite is within the region dominated by the influence of the geomagnetic field so that measurements of the relatively undisturbed interplanetary field cannot be made. The corresponding gaps in the data can be seen in Fig. 2.

The large-scale direction of the field shown in the inner portion of Fig. 2 reversed twice during each solar rotation. In two sectors each occupying about 2/7 of the total longitude the field was directed away from the sun, and in one sector of width about 2/7 and one sector of width about 1/7 of the total longitude the field was directed toward the sun. This interplanetary magnetic structure co-rotates with the sun and therefore sweeps past the earth once every 27 days. Changes associated with this structure, as observed at the earth, are therefore not to be interpreted as being caused by a predominantly radial propagation from the sun but rather as being associated with the rotational motion of the structure past the earth. At the sector boundaries the change in field direction occurs within a few minutes. Thus the magnetic neutral sheet at a sector boundary is thin, and may produce impulsive effects as it sweeps past the earth. Approximate times at which this structure was observed at the earth by Imp-1 during the first solar rotation are labeled in Fig. 2.

The first orbit contains an exception to the proposed sector structure that is not yet understood. During the second orbit the velocity of the solar wind was considerably higher than average (*4*), so that in terms of a regular longitudinal structure sweeping past the earth the change from − to + arrived "too soon." For the 2½ solar rotations beginning 13 December 1963, the average solar wind velocity for each orbit (*4*) varied by less than 10 percent, and therefore the large-scale