REDOX INDICATOR "CONTRAST" ON THE SURFACE ON VENUS.


There is a strong oxidizer H2SO4 in the upper troposphere of Venus. Below, the measured contents of O2 and CO/I, 2/ support a suggestion on disequilibrium state or local equilibria with spatio-temporal variability 3/. The results of the only in situ measurements on the surface, LNMS Pioneer-Venus data, on S-bearing species were considered as an artifact 4, 5/. Thus now there is no direct information on the redox state on the surface of Venus. The high temperatures are favorable for equilibration. Taking into account the C2H6 LNMS data 4/, the calculated oxygen mixing ratio (x0) is about 10^-3, but the O2 Venera I3, I4 GC data above 3,5 km 6/ show >25 orders of magnitude higher (x0=10^-2)(Fig.1).

To estimate the redox conditions on the surface assuming the equilibrium state the redox indicator "Contrast" was fitted on the supporting rings of Venera I3 and I4 probes (Fig.2). The indicator consists of the metallic frame holding an asbestos paper impregnated by sodium pyrovanadate (albedo, A~80%). If x0 corresponds to white field on Fig.I, the pyrovanadate remains white, while if x0 corresponds to dark field, the pyrovanadate darkens (A<30%). By the reduction to V2O4 (blue) and/or to V2O5 (black):

\[ \text{Na}_4\text{V}_2\text{O}_7 + \text{CO}_2 + 3\text{CO} = \text{V}_2\text{O}_4 + \text{V}_2\text{O}_3 + 4\text{Na}_2\text{CO}_3 \]

The transition rate is ~15 min as laboratory tests have shown. The transition region is hatched on Fig.I. Because of the inaccuracy of the thermodynamic values as well as the possibility of the incomplete equilibration the magnetite stability field is carefully considered as the region of uncertainty.

During the descent in the atmosphere the asbestos paper was protected from aerosols by a metallic plaque with melted rivets, which were fused at ~12 km (~380°C), and the plaque was thrown away by aerodynamic flow. Some dust is to be seen both on the indicator and another details (Fig.2). The comparison of the measured albedos of the different features permits to infer albedo of the paper without dust ranged from 2 to <30% (Venera I3 and I4). Thus the sodium pyrovanadate on the surface of Venus was subject to darken.

Hence at a thermodynamic equilibrium on the surface (Fig.1) CO >10ppm, O2<10^-23, SO_3<SO_2, COS; the stable Fe-bearing phases are Fe-silicates (+Fe-oxides) or magnetite rather than hematite. This redox state is compatible with the CO-content but drastically incompatible with the O2-content both measured by Venera GC above 3,5 km/I, 6/ . This implies either (i) a distinct nonequilibrium down to the surface, or (ii) unreliability of the O2 peak attribution in Venera GC data, or (iii) transition to the thermochemical equilibrium zone at the level 3,5 (+2-3) km. A possibility of (i) seems to be supported by kinetic estimations/7/; then a reducing gas (apparently CO) reacted with V^3+ as well as high O2-content could coexist on the surface. For (ii) the constancy of O2-content at altitudes ranged from 58 km (H2SO4, -10°C) to 3,5 km (gas medium, +450°C) is questionable. As an evidence for (iii) it would be useful to revise the LNMS data on the S-bearing species relation from 20 to 0 km without an assumption on the constant mixing ratio of these in the atmosphere /5/; this assumption may
be not fully correct. For now some approach to the equilibrium on the surface is necessary for the chemical weathering variations as a function of altitude, as it has been proposed by /8,9, 10/ and supported later by /II/. 