PHOSPHORUS COMPOUNDS IN JOVIAN ATMOSPHERE; S.P.Borunov and V.A.Dorofeyeva, Vernadsky Instritute of Geochemistry and Analytical Chemistry, USSR Academy of Science, 117334 Moscow.

The detection of PH_3 as well as CO and GEH_4 in upper atmospheric levels of the jiant planets is the evidence of chemical nonequilibrium of the atmospheres of these planets. According to /1-3/ PH_3 is the most abundant phosphorus gas on Jupiter only at T>1000 K, it is oxidized to P_4O_6 by water vapor in the 800-1000 K range. Subsequently the P_4O_6 is condensed in a form of $NH_4H_2PO_{4(s)}$ at $T \approx 400$ K (figures 1 and 2, the dashed lines).

Based on these data Prinn and Lewis /4/ proposed that the scale for vertical mixing of PH_3 from the deep atmospheric levels (T>1000 K, $P \sim 300$ bar for Jupiter) up to a cooler region of the atmosphere is well shorter then the time scale for the destraction of PH_3.

However values of $\Delta G^o_f(P_4O_6)$ used in /1-3/ are based on approximate values of $\Delta H^o_f(P_4O_6,g,298.15)$ /5/.

The results of calculations with new consistent thermodynamical information /6/ are presented in figures (the solid lines). The equilibrium chemistry of phosphorus assuming solar abundance for P and O is presented in fig.1. The case of deplation of oxygen in 50 times relative to solar abundance /7/ is shown in figure 2.

PH_3 and PH_2 radical are the most abundant phosphorus gases at T>500 K. Below 400 K the oxiding forms: P_4O_{10}, P_4O_9, P_4O_8 are found to be the most abundant. Abundances of other phosphorus gaseous compounds (P_4O_6, PO, P_4O_7, HPO, P, PH, PS, PN) are lower than 10^{-12} in the temperature range 300-200 K.

If the total oxygen abundence in Jovian atmosphere is similar to the solar abundance (fig.1) the level of PH_3 transport is corresponding to $T \approx 450$ K ($P \approx 25$ bars). In that case the instrumental detection of PH_3 could be considered as an evidence of disequilibrium atmospheric state versus the phosphrous compounds.

If the total oxygen abundance is similar to the total oxygen abudance obtained from the H_2O data /7/ then observed abundance of PH_3 is equal to its equilibrium value (fig.2).

The P_4O_{10} is probably the only condensed phase on the upper atmospheric levels from the set of revied species ($P_{(s)}$, $P_4S_{3(s)}$, $P_3N_{5(s)}$, $P_4O_{10(s)}$).

The analogous behavior of P-bearing compounds supposedly could be observed in the other major planetary atmospheres.

PHOSPHORUS IN JOVIAN: Borunov S.P., Dorofeyeva V.A.

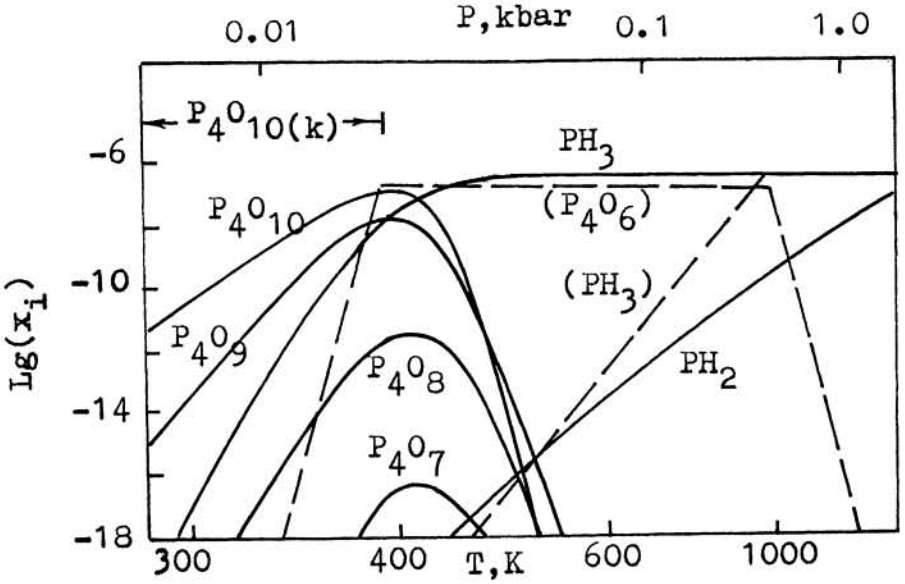

Fig.1 Equilibrium abundances of phosphorus gases along the Jupiter adiabat. Calculations were done for solar and 1.5xsolar abundances of P and for solar of O.The dushed lines represent the previous calculations /1-3/.

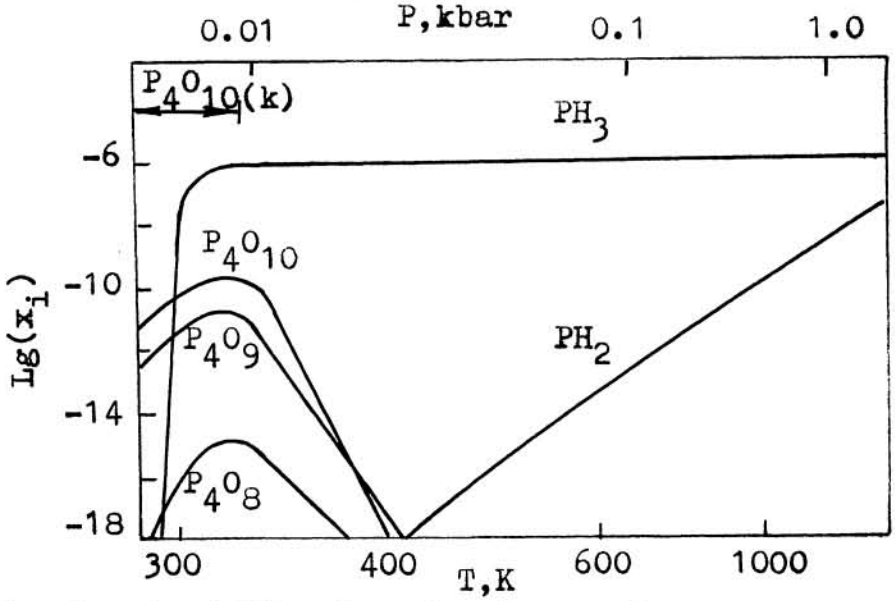

Fig.2. See fig.1. 1/50 solar abundance of oxygen.

References: /1/ Barshay S.S., Lewis J.S. (1978) Icarus V.33,P.593. /2/ Prinn R.G., Larson H.G. (1984). In: Saturn,ed. Gehrels T. Tucson.P.88. /3/ Fegley B.Jr., Prinn R.G. (1986) LPS XVII.P.222. /4/ Prinn R.G., Lewis J.S. (1975) Science .V.190.P. 274. /5/ Koerner W.E., Daniels F. (1952) J.Chem.Phys.V.20.P.113. /6/ Thermodynamical properties of individuel substances (1978) Moscow. Nauka (in Russian). /7/ Bjoraker G.L., Larson H.P., Kunde V.G. (1986) Astrophys.J.V.311,P.1058.