PHOSPHORUS COMPOUNDS IN JOVIAN ATMOSPHERE; S.P. Borunov and V.A. Dorofeyeva, Vernadsky Institute 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 giant 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$_4$O$_6$ by water vapor in the 800-1000 K range. Subsequently the P$_4$O$_6$ is condensed in a form of NH$_4$H$_2$PO$_4$(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 destruction of PH$_3$.

However values of $\Delta G^o_f$(P$_4$O$_6$) used in /1-3/ are based on approximate values of $\Delta H^o_f$(P$_4$O$_6$,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 depletion 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$_4$O$_{10}$, P$_4$O$_9$, P$_4$O$_8$ are found to be the most abundant. abundances of other phosphorus gaseous compounds (P$_4$O$_6$, PO, P$_4$O$_7$, HPO, P, PH, PS, FN) are lower than 10$^{-12}$ in the temperature range 300-200 K.

If the total oxygen abundance 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 phosphorus compounds.

If the total oxygen abundance is similar to the total oxygen abundance obtained from the H$_2$O data /7/ then observed abundance of PH$_3$ is equal to its equilibrium value (fig.2).

The P$_4$O$_{10}$ is probably the only condensed phase on the upper atmospheric levels from the set of revied species (P(s), P$_4$S$_3$(s), P$_3$N$_5$(s), P$_4$O$_{10}$(s)).

The analogous behavior of P-bearing compounds supposedly could be observed in the other major planetary atmospheres.
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 dashed lines represent the previous calculations /1-3/.

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