VENUS' OUTGASSING MODEL BASED ON ARGON ISOTOPIC DATA Volkov V.P., Frenkel M.Ya. Vernadsky Institute of Geochemistry and Analytical Chemistry, Moscow, USSR. The history of terrestrial atmosphere formation is investigated using the noble gas abundance in the atmosphere, crust and mantle [1,2,3]. Unfortunately in respect of Venus the only reliably determined isotopic ratio of noble gases in its atmosphere is perhaps 40Ar/36Ar=1.2 (Cf. with 300 in the terrestrial atmosphere). Radiogenic 40Ar inventories are estimated as about 1.4E+19 g whereas the nonradiogenic 36Ar as 1.2E+19g [4]. 40Ar inventories on Venus are by a factor of 5 lower in relation to the terrestrial value, but 36Ar is by a factor of 60 more abundant. Already in [5] it was suggested that within the first billion years of Venus' history almost all 40Ar from the crust and mantle was outgassed. This assumption was supported by the geologists [6,7]. In [8] the outgassed fraction of Venus' mantle was estimated using the mass ratio of 40Ar in the atmosphere and 40K in the mantle (potassium content was taken as 320 ppm similar to the terrestrial value). Outgassed fraction was estimated as 8.5% or 28%, the former value corresponding to the equality of the mantle masses while the latter corresponding to the equality of mantle volumes of both planets. The third scenario included the Venus' crust as the sole reservoir of 40Ar with the potassium content of 1.16%. Here the crustal thickness was predicted in the range of few kilometers. We made an attempt to use the terrestrial outgassing models based on the simple three-reservoir simulation involving mass-transfer coefficients of 40K, 40Ar, 36Ar [1]. The following initial data were used: total 40Ar outgassing rate constant alpha = 0.01E-9 yearE-1 (mantle - atmosphere); 40Ar outgassing rate constant beta = 0.37E-9 yearE-1 (crust-atmosphere); crust and mantle masses as well as 40K/K total and (40Ar/36Ar) initial in mantle were taken as similar to [1]; Ar inventories in Venus' atmosphere were taken from [4]. The following constraints were used: 80 ppm < K mantle < 400 ppm, 40Ar/36Ar mantle>15.000. The results are presented on Fig 1,2. The unknown parameters are as following: F-outgassed fraction of primary mantle; td - outgassed time; gamma-transportation rate of potassium from the mantle to the crust. Besides 40Ar atm /40K init , 40Ar/ 36Ar in mantle, 40K mantle, 40K init were calculated. According to [1] one more constraint in the K-Ar system is to be taken into account: gamma is much more than alpha. It is evident that this constraint in relation to Venus could be satisfied only at potassium content in the crust to be lower than 1% i.e. the terrestrial potassium content in Venus' crust could not be in consistency with 40Ar/36Ar in mantle constraint. The maximal value of 40Ar/36Ar in mantle corresponding to 99% of outgassed fraction of mantle was found to be of one order of magnitude lower in relation to similar terrestrial values. In order to obtain the "terrestrial-like" relations we assumed the potassium content in Venus' crust as 0.1% (tholeiitic basalts of Vega 2) as well as the 36Ar content was taken equal to the terrestrial value. The latter assumption means that the hypothesis of initial similarity of argon inventories in proto-Venus and proto-Earth was accepted. The external sources of 36Ar are in agreement with this approach [9,10]. Fig.2 indicates to a conclusion on the high outgassed fraction value (F>93%) providing the mentioned above constraints on 40K mantle and 40Ar/36Ar in mantle. Hence the total 40Ar inventory should be outgassed to Venus' atmosphere during the first 0.5 b.y. The preliminary estimates indicate that the increase of 40Ar outgassing rate constant up to alpha=0.053 corresponding to the "slow outgassing" in [1] would result in abrupt increase of outgassing time up to 1.2 b.y. In accord with [11] this alpha-value could be corresponded only with the terrestrial estimate of volcanic material volume per year (~10kmE+3yearE-1). This high intensivity of volcanic processes on Venus is not supported by geological considerations. May be the successful termination of the Magellan mission would obtain some new information on the problem in question. To day we are able to make a careful conclusion: the Venus' crust should be markedly depleted in potassium in relation to the Earth providing the equality of the crust and mantle masses of both planets. If so the nonradiogenic argon enrichment of Venus' atmosphere is due to the external factors (solar wind, impact) on the pregeological stage of Venus' history. References [1] M.Ozima, F.Podosek. Noble gas geochemistry. Cambridge Univ.Press, 367pp. 1983. [2] I.Tolstikhin. Isotope geochemistry of helium, argon and rare gases. Nauka, Leningrad, 200pp., 1986. [3] C.J.Allegre et al. Earth Planet. Sci. Lett. 81, 127 - 150, 1987. [4] U. von Zahn et al. In: Venus. Univ. Arizona Press, 299-430, 1983. [5] J.B.Pollack, D.C.Black, Icarus, 51, 169-198, 1982. [6] J.W.Head, L.Wilson, J. Geophys. Res. B, 91, 9407-9446, 1986. [7] A.T.Bazilevsky, J.W.Head. Geology of Venus, Ann. Rev. Earth Planet. Sci., 16, 295-317, 1987. [8] D.L. Turcotte, G.Schubert, Icarus, 74, 36-46, 1988. 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Fig.1

Outgassing of Venus at content of potassium in the crust of 1.91 %

alfa=0.01*10^-9 year^-1; beta=0.10*10^-9 year^-1; gamma alfa

Ar inventory from 4

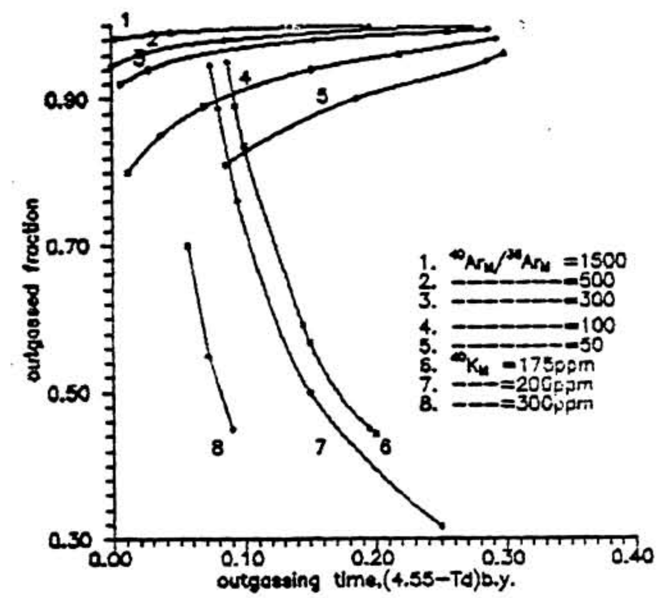

Fig.2

Outgassing of Venus at content of potassium in the crust of 0.1 %

alfa=0.01*10^-9 year^-1; beta=0.37*10^-9 year^-1;

Ar inventory is similar to terrestrial