CARBON CHEMISTRY OF VOLCANIC GASES ON IO. B. Fegley, Jr.[1,2] and M. Yu. Zolotov[2], [1]Planetary Chemistry Laboratory, bfegley@levee.wustl.edu, [2]Department of Earth and Planetary Sciences, Washington University, St. Louis, MO 63130, zolotov@zonvark.wustl.edu.

Introduction: Earth-based, *HST*, and *Galileo* spacecraft observations show high temperature silicate volcanism on Jupiter's satellite Io. Atoms and/or ions of S, O, Na, K, Cl, and H are present in the Io torus and neutral clouds. Sulfur dioxide, S, S_2, and SO are observed in the Pele plume; SO_2 in the Loki plume, and SO_2 and SO in other plumes. We have previously modeled chemistry of S, O, Na, K, Cl, and H in volcanic gases on Io [1-6]. Here we model carbon chemistry of volcanic gases. Our motivation is threefold. (1) *Voyager* upper limits for CO_2, OCS, CS_2, and CH_4 in the Loki plume are fairly high (~0.02-3% relative to SO_2). (2) *Galileo* observed hydrogen being emitted from Io with an abundance of a few % relative to Na. Carbon could also be present if H is still present on Io. (3) Carbon to sulfur atomic ratios in lunar basalts and basaltic achondrites are a few percent or higher. It is plausible that carbon remains in the silicate portion of Io and can be volcanically outgassed.

Model and Methods: Our nominal model is for Pele volcanic gases because the temperature, pressure, and bulk composition of Pele volcanic gases are fairly well constrained [1,5]. The nominal model has T = 1440 K, $P = 10^{-5.16}$ bar, O/S = 1.521, Na/S = Cl/S = 0.05, and Na/K = 10. The temperature, pressure, and O/S ratio are constrained by the abundances of SO_2, SO, S, and S_2 in the plume. The Na, K, and Cl abundances are constrained by observations of the Io torus. We also studied the effects of T (1000-2000 K), P (10^{-8} - 10^{2} bar), and bulk composition (O/S, C/S, H/S atomic ratios) on carbon chemistry of volcanic gases. Computational methods, observational constraints, and thermodynamic data are described in [1-6].

Results: Our modeling predicts that CO and CO_2 are the two major carbon gases followed by OCS, which is much less abundant. The mole fractions of CO, CO_2, and OCS in the nominal model are 0.055%, 0.050%, and ~10^{-7}, respectively. Other C gases have very low mole fractions (<10^{-9}), far below the *Voyager* upper limits, and are unimportant. The *Voyager* upper limit for CO_2 in the Loki plume is $CO_2/SO_2 = 2.5\text{-}7.5 \times 10^{-4}$. A comparison of this upper limit with CO_2/SO_2 ratios calculated as a function of the bulk C/S ratio suggests a bulk C/S atomic ratio of ~10^{-3} or less in volcanic gas at Pele. At constant pressure and composition, higher temperatures increase the CO/CO_2 ratio; at constant temperature and composition higher pressures decrease this ratio. At constant T and P, higher O/S ratios favor CO_2, while lower O/S ratios favor CO. Our results suggest that CO and CO_2 should be observable in Pele-type volcanic plumes on Io. If detected, the CO/CO_2 ratio can be used to estimate T, P, and fO_2 of Io's volcanic gases and magmas. OCS may be observable in high pressure and/or low temperature volcanic gases.

References: [1] Zolotov, M. Yu. and Fegley, B., Jr. (2000) *LPS XXXI*, abstract no. 2098. [2] — (1999) *Icarus 141*, 40-52. [3] — (1998) *Icarus 133*, 293-297. [4] — (1998) *Icarus 132*, 431-434. [5] — (2000) *GRL*, in review. [6] B. Fegley, Jr. and Zolotov, M. Yu. (2000) *Icarus*, in review.

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