Geophysical Research Abstracts, Vol. 8, 03270, 2006
SRef-ID: 1607-7962/gra/EGU06-A-03270

ů An overview: 30 years of estimating volcanic gas emissions into the atmosphere

M.M. Halmer

(1) Department of Earth Sciences, (2) University of Bristol, Wills Memorial Building, Bristol BS8 1RJ, United Kingdom, (E-mail: Martina.Halmer@bristol.ac.uk)

Diverse surveys of global data sets considering annual volcanic gas emissions into the atmosphere. The estimates range from 1.5 - 50 x 10**12 g/a SO2. One group includes the very low estimates from Kellogg et al. (1972) with 1.5 x 10**12g/a SO2, Friend (1973) with 4.0 x 10**12 g/a SO2, Cadle with 7.0 x 10**12 g/a SO2 and Granat et al. (1976) with 6.0 x 10**12 g/a SO2, which are one magnitude lower than the estimates from group two and three. A second group includes estimates of SO2 emissions from Stoiber and Jepsen (1973) with 10.0 x 10**12 g/a SO2, Le Guern (1982) with 10.0 x 10**12 g/a SO2, Berresheim and Jaeschke (1983) with 15.2 x 10**12 g/a SO2, Stoiber et al. (1987) with 18 x 10**12 g/a SO2, Andres and Kasgnoc (1997) with 13.0 x 1012 g/a SO2 and our estimate with 15.0 - 21.0 x 10**12 g/a SO2. The third group shows the highest amounts of annual SO2 emission including Bartels (1972) with 34.0 x 10**12 g/a SO2, Naughton et al. (1975) with 47.0 x 10**12 g/a SO2, Lambert et al. (1988) with 50.0 x 10**12 g/a and Graf et al. (1997) with 28.0 ś 8 x 10**12 g/a SO2. The differences of the annual global volcanic SO2 emissions by those authors are caused by different starting-points for the estimates. Kellogg et al. (1972) calculated an annual SO2 emission by volcanoes using 0.5% of gas erupted with the lava. They assumed the amount of 1.2 x 10**18 g/a for the total annual lava volume. Thus they excluded the silent degassing, which partly explains the lower amount of SO2 emission in the order of one magnitude. Cadle (1975) based his estimate also on the annual lava volume of 1.2 x 10**18 g/a. He achieved an higher amount compared to Kellogg et al. (1972) because Cadle used 2.5% of gas erupted with the lava instead of the 0.5% used by Kellogg et al. The second group includes SO2 amounts between 10.0 and 21.0 x 10**12 g/a. The calculation by Stoiber and Jepsen (1973) is based on only five Central and South American volcanoes. The SO2 emission calculated by

Stoiber et al. (1987) was based on 35 volcanoes monitored by COSPEC. They related the SO2 output to the size of the degassing plume. They observed 102 volcanoes in the time period between October 1981 to October 1982. The amount of 18.7 x 10**12 g/a SO2 divided in 35% from silent degassing and 65% gas from explosive degassing. Berresheim and Jaeschke (1983) calculated 15.2 x 10**12 g/a SO2 with 14.2 x 10**12 g/a coming from silent degassing and only 1.0 x 10**12 g/a from explosive eruptions. They assumed that 365 active volcanoes are emitting plumes. The number of explosively erupting volcanoes of 365 is very close to our data base of active volcanoes (˜ 360 active volcanoes), which had at least one explosive eruption during the past 100 years. Lambert et al. (1988) normalized the SO2 estimate of trace metals to Polonium (210Po). 210Po is the last radioactive nuclide of the 238U/226Ra series. Lambert et al. (1982) estimated, owing to a global atmospheric budget of 222Rn and its decay products, that volcanoes represent about 50% of the global source of 210Po to the atmosphere. On the basis of the volcanic contribution of 50% of 210Po of its total injection into the atmosphere Lambert et al. (1988) estimated the amount of 50 x 10**12 g/a for the volcanic global SO2 emission. Lambert et al. (1988) used the SO2/210Po ratio for a limited number of sampling sites and extrapolated this to global total SO2 emission. The estimate by Andres and Kasgnoc (1997) is based on a 25-year history of SO2 measurements at volcanoes by TOMS and COSPEC. They divided the volcanoes into continuously and sporadically erupting volcanoes. On the basis of the power law function of Brantley and Koepenick (1995), Andres and Kasgnoc (1997) extrapolated the amount of global volcanic SO2 flux sums up to 13.0 x 10**12 g/a over the past 25 years. Halmer et al's (2002) value of 15 - 21 x 10**12 g/a SO2 is based on more than 360 active subaerial volcanoes and the fluxes of 50 directly monitored volcanoes. They could achieve a higher accuracy with an increased amount of directly monitored volcanoes used in their estimate to almost 15% of the total subaerial active volcanoes and by including significant parameters for a more precise extrapolation from directly measured SO2 emission on non-directly monitored volcanoes than it were considered in the previous estimates.

References: Andres R.J. and Kasgnoc A.D., 1997. A time-averaged inventory of subaerial volcanic sulfur emissions. J. Geophys. Res. 103: 25251-25261. Bartels O.G., 1972. An estimate of volcanic contributions to the atmosphere and volcanic gases and sublimates as the source of the radioisotopes 10Be, 35S, 32P, and 22Na. Health. Phys. 22: 387-392. Berresheim H. and Jaeschke W., 1983. The contribution of volcanoes to the global atmospheric budget. J. Geophys. Res. 88: 3732-3740. Brantley S.L. and Koepenick K.W., 1995. Measured carbon dioxide emissions from Oldoinyo Langai and the skewed distribution of passive volcanic fluxes. Geology 23: 933-936. Cadle R.D., 1975 Volcanic emissions of halides and sulfur compounds to troposphere and stratosphere. J. Geophys. Res. 88: 1650-1652. Friend J.P., 1973. The global sulfur cycle. In: S.I. Rasool (Editor), Chemistry of the lower atmosphere, Plenum New York: 177-201. Graf H.-F., Feichter J. and Langmann B., 1997. Volcanic sulfur emissions: estimates of source strength and its contribution to the global sulfate distribution. J. Geophys. Res. 102: 10,727-10,738. Granat L., Rodhe H. and Hallberg R.O., 1976. The global sulfur cycle, in nitrogen, phosphorus, and sulfur - global cycle. In: BH Svensson und R Söderlund (Editors) SCOPE report, royal swedish academy of science, Orsundsobro, Sweden, pp. 90-110. Halmer M.M., Schmincke H.-U. and Graf H.-F., 2002. The annual volcanic gas input into the atmosphere, in particular into the stratosphere: a global data set for the last 100 years. J. Volcanol. Geotherm. Res. 115: 511-528. Kellogg W.W., Cadle R.D., Allen E.R., Lazrus A.L. and Martell E.A., 1972. The sulfur cycle. Science 175: 587-596. Lambert G., Le Cloarec M.-F., Pennisi M., 1988. Volcanic output of SO2 and trace metals: A new approach. Geochim. et Cosmochim. Acta 52: 39-42. LeGuern F., 1982. Les debits de CO2 and SO2 volcanoliques dans l'atmospherre. Bull. Volcanol. 45: 197-202. Naughton J.J., Greenberg V.A. and Goguel R., 1975. Incrustations and fumarolic condensates at Kilauea volcano, Hawaii: field, drill-hole and laboratory observations. J. Volcanol. Geotherm. Res. 1: 149-165. Stoiber R.B. and Jepsen A., 1973. Sulfur dioxide contribution to the atmosphere by volcanoes. Science 182: 577-578. Stoiber R.E., Williams S.N. and Huebert B., 1987. Annual contribution of sulfur dioxide to the atmosphere by volcanoes. J. Volcanol. Geotherm. Res. 33: 1-8.