The 2004 eruption of Mt. Asama -Explosion earthquakes, air shocks and volcanic deposits-

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During the 2004 Asama eruptions, 5 moderate summit eruptions were observed. For these eruptions, acoustic and geological measurements were conducted in addition to the seismic observations. The relation between amplitude of the vertical single force component and the amount of the volcanic deposits was not necessarily positive. The eruption on September 1 (Event 1) was the largest with respect to the amplitude of the air shock and the amount of the volcanic deposits, while the eruption on September 23 (Event 2) was far more intense than the other 4 eruptions from the viewpoint of the single force amplitude. On the other hand, the air shock intensity and the amount of volcanic deposits have a positive correlation for all the 5 events.

We consider an eruption model proposed by Kanamori et al. (1984). In the model, a shallow vertically oriented cylindrical conduit is initially pressurized and sealed at the top by a lid. An eruption is simulated by the sudden removal of the lid. According to this model, the intensity of the vertical single force is F=SP, where S is the cross section of the conduit and P is the pressure in the conduit. The source of air shock would be the lid pushed and accelerated upward by the pressure in the conduit. The excess pressure p is proportional to the rate of mass outflow. The mass outflow rate is proportional to $S*A$, where A is the vertical acceleration of the lid. In addition, the acceleration A, the force F and the mass of the lid M are related as $F=M*A$. Thus, the far field pressure p is proportional to $S*F/M$.

The single force amplitude of explosion earthquakes, the air shock amplitude and the volcanic deposits are not necessarily positively related each other. The single force intensity for Event 2 is nine times larger than that for Event 1, while the air shock amplitude for Event 2 is only a third of that for Event 1. Under the assumption that the cross-section S had not changed between Event 1 and Event 2, the difference in the intensity of the single force component is attributed to the difference of the pressure P in the conduit. It is thus interpreted that the pressure in the conduit before Event 2 was nine times larger than that before Event 1. As mentioned above, the air shock amplitude p is proportional to the force F, and, at the same time, inversely proportional to the mass of the lid M. To explain the air shock amplitude for Event 2, the mass of the lid for Event 2 must be nearly 30 times larger than that for Event 1. The large difference in the lid mass is in good agreement with the observation that the bottom of the summit crater was filled with a lava mound 65m thick before Event 2 (Oki et al., 2005). The lava mound was formed after Event 1, and was partially blown off during Event 2. Although the pressure in the conduit before Event 2 was 9 times higher, probably due to a sealing effect by the thick lava mound, the acceleration of the lid was only a third due to the large mass of the lid. The low acceleration of the lid resulted in the small amplitude radiation of sound. The other three eruptions can be interpreted in the same manner. The explosions on September 29 (Event 3), on October 10 (Event 4), and on November 14 (Event 5) are characterized by moderate conduit pressure and the large mass of the lid. It is only in Event 1 among the five explosions where there was no thick lava mound before eruption.

Only the mass of ash that was emitted outside of the summit crater rim contributed to the mass of the volcanic deposits actually measured. Probably the mass of ash was strongly related to the final velocity reached by the lid vertically accelerated before breaking into small volcanic ejecta. Since the air shock amplitudes are proportional to the vertical acceleration of the lid, the positive relation between the air shock amplitudes and the volcanic deposits is easily understood.