DYNAMICS OF CONFINED LIQUID MASS, SPREADING ON PLANET SURFACE. A. A. Kostrikov, Laboratory of Comparative Planetology, Vernadsky Institute, 19, Kosygin St, 117975, Moscow, Russia (kostrikov@geokhi.ru).

Introduction: Ice or permafrost covers (completely or partially) appreciable number of planets and satellites of Solar system. By several ways subsurface water can spring away [1-4]. What are the basic features of the confined water mass spreading? Generally speaking behavior of liquid mass (spot) poured out on the surface of planet depends on many parameters. This investigation had been carried out to solve a simple problem of non-viscous liquid spreading on smooth surface of rotating planet.

Model: The model bases on shallow-water equations with a source. It is proposed that source has a circle form and input of liquid decreases with time exponentially. In dimensionless form task solution depends on three non-dimensional numbers:

$$Fric = \frac{C_d}{f}\sqrt{\frac{g}{3}}$$

, T_s/T and Rim/L, where g is acceleration of gravity, f Coriolis acceleration, C_d friction coefficient, $H=ST_s$ a scale of spot depth, S intensity of source, T_s a scale of discharge duration, $T=1/f$ a time scale, Rim source circle radius, $L=\sqrt{gH}/f$ is length scale. (All values are non-dimensional below.) For simulation of the spot flow the method of large particles has been used [5-7].

Numerical experiments: Simulations of liquid spreading on Mars, Earth, Europa and Ganymede with Rim=10 km, $S=10^{-3}$ m/sec, $T_s=10^4$ sec and C_d from 10^{-7} to 10^{-4} have been made. Values of other input parameters and obtained scales are in Table 1.

	g, m/sec^2	f, sec^{-1}	T, sec	H, m	L, km
Mars	3.73	1.23 10^{-4}	8.1 10^3	10	50
Earth	9.81	1.26 10^{-4}	7.9 10^3	10	79
Europa	1.35	3.56 10^{-5}	2.8 10^4	10	104
Ganymede	1.42	1.77 10^{-5}	5.7 10^4	10	214

Table 1. Values of parameters and scales.

Behavior of liquid spot depends on magnitude of $Fric$. If $Fric$>~0.1 the spot performs radial motion. If $Fric$<0.1 liquid mass starts to oscillate from center to periphery and back, clock- and anticlockwise. Velocity vector moves clockwise at any point of spot. At sufficiently small $Fric$ the spot looks like a contractive and unclasping ring (Fig. 1). The origin of these waves is the same as Poincare's waves [8]. In t=2 spot volume

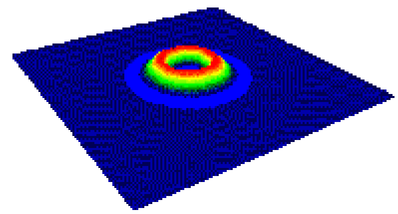

Figure 1. A view of oscillating spot.

(Q) ceases to rise and holds constant up to simulation termination (Fig.2). Since this time the rate of spot in-

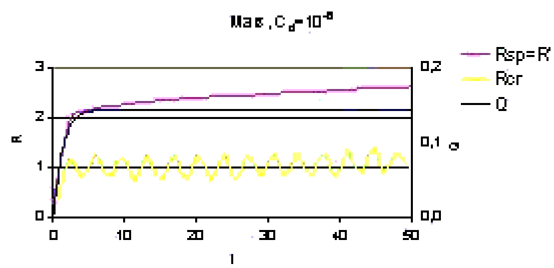

Figure 2. Time dependence of spot volume (Q), spot radius (Rsp) and wave crest radius (Rcr). Mars, $C_d=10^{-8}$.

creasing drops abruptly and then oscillations begin with period of 3.78 and amplitude equals to 0.45. Worthy of note that in contrast to amplitude this value of period is practically constant for all experiments with oscillations. The spot starts to spread strongly with decreasing $Fric$ under 0.001. Following its front wave crest moves to spot periphery. If $Fric$ > 0.005, mean position of crest approaches spot center. Further amplification of $Fric$ results in confused oscillations and their vanish at $Fric$ > 0.2.

An objective view of spot flow gives dimensional data (Table 2), where Rpl is radius of planet or satellite. One might see that in order to increase upto tenfold initial extent (120-150 km) it will be necessary a little more then 4 terrestrial days for spots on Mars and Earth, 16 days on Europa and a month on Ganymede.

	***T**_{end}*, days	***Rsp***	***Rsp***, km	***Rpl***, km	***Rsp/ Rpl***	***Rsp/ Rim***
Mars	4.7	2.6	132	3390	0.039	13
Earth	4.6	1.9	146	6371	0.023	15
Europa	16.3	1.2	125	1562	0.080	12
Ganymede	32.8	0.7	149	2634	0.057	15

Table 2. Dimensional characteristics of spot movement.

Discussion and conclusions: Being used interval for friction coefficient C_d can appear moved to the range of too small values (For example, C_d = 0.0025 for smooth concrete canals [9]). Indeed, you must use appropriate values of C_d to model water flows with rates smaller 10 m/sec. The point is that the higher speeds generate cavitation cushion made of gas bubbles, which reduces friction sharply [10]. Besides, if an ejected mass is a steam and gas mixture originally, it flows at lesser friction.

One can obtain small values of ***Fric*** not only by reduction of friction coefficient, but by lessening of acceleration of gravity, or increasing of speed of planet rotation or ejected liquid mass. Thus erupted liquid will spread on planet like a pulsing ring in case that its mass is sufficiently large, and this ejection takes place in high latitudes of a small, fast-rotating planet with smooth surface. Conclusion follows that requirement ***Fric*** <0.1 must be fulfilled to realize such structures.

Very likely that these structures can leave behind corresponding ring-shaped trace.

References: [1] Carr M.H. (1979) *JGR, 84,* 2995-3007. [2] Wilson L. and Head J.W. (2003) *LPS, XXXIV*, *1186.pdf.* [3] Wilson L., et al. (2002), *AGU, Fall Meeting, 12,* abstract #P12A-0366. [4] Baker, A.L. and Nolan, M.C. (1996) *189th AAS Meeting, #19.01, Bull. of AAS, 28, №12*, p.1299. [5] Davydov Yu.M. (1990) *Large-particle method. In: Encyclopedia of mathematics, vol.5,* p. 358-360. [6] Kostrikov A.A. (1992) *Russian Meteorology and Hydrology, 9,* 74-83 (in Russian). [7] Kostrikov A.A. (2003) *Data of Glaciological Studies, 95*, 22-27 (in Russian). [8] Gill A.E. (1982) *Atmosphere-Ocean Dynamics.* [9] Jeffreys H. (1925) *Phil. Mag. 6, 49,* 793-807. [10] Baker V.R. and Costa J.E. (1987). *Catastrophic Flooding,* p.1-21.