CONVECTION, MAGNETISM, ORBITAL RESONANCES, IMPACTS, AND VOLCANISM: ENERGIES AND PROCESSES IN THE SOLAR SYSTEM. DIDACTIC ACTIVITIES. G. Castilla[1], C. López[2], M.A. de Pablo[3] and L. Martín[4]. [1]Seminar on Planetary Sciences. Facultad de Ciencias Geológicas. Universidad Complutense de Madrid. 28040 Madrid. Spain. (gabrielplanetas@yahoo.es), [2]I.E.S. María Zambrano. C/ Alpujarras, 52. 28915 Leganés, Madrid. Spain, [3]Área de Geología. Dpto. de Matemáticas y Física Aplicadas y Ciencias de la Naturaleza. ESCET. Universidad Rey Juan Carlos. 28933 Móstoles, Madrid. Spain. [4]I.E.S. Isabel 'La Católica'. C/ Alfonso XII, 3-5. 28014 Madrid. Spain.

Introduction: In many occasions the study of other planetary bodies in the classrooms is made only in terms of the external geological processes: volcanoes, cannons, impact craters, channels, dunes,… and all those forms of the surface that permit us to compare the forms of the relief of the Earth with that of other planetary bodies. However, they are many more links between our planet and the other planetary bodies of rocky and icy type (planets and satellites). The internal energy or the relationship between several planetary bodies is also commons forms of energy or processes too many bodies of our solar system. In this work we show some didactic experiences, developed in the secondary education classrooms as well as with the general public, directed to make known some of the processes and sources of energy more common between the planets and satellites of the Solar System.

Convection: the convective processes are not given only in our atmosphere, oceans and mantle, but also are produced in the atmospheres of other planets, and even in the underground oceans of some icy satellites [1] [2] [3].

The activities developed in the classroom to explain these processes have consisted of, on the one hand, the modelization of in the middle liquid convection through the warming with a candle of the oil contained in a small glass recipient in the one which also it was introduced colored water that permitted to observe its rising movement to be heated and falling movement to be cooled (Fig. 1).

Fig. 1: didactic experience of the liquid convective processes.

With this simple and known activity [4] it is possible to explain the convective processes that could be produced in the interior of some planetary bodies (Earth, Venus, Mars,…) or in the oceans of the Earth, in the possible *Oceanus Borealis* of Mars, or in the oceans under the surface of some icy satellites.

On the other hand, for the modelization of the convective processes of gases was employed a novel experiment through the one which is introduced a smoke column in an empty CD-Rom box (Fig. 2). With this simple experiment is possible to explain the operation of the atmospherical dynamics in our planet, or in the mild atmosphere of Mars or in that of the gaseous bodies as Jupiter or Saturn.

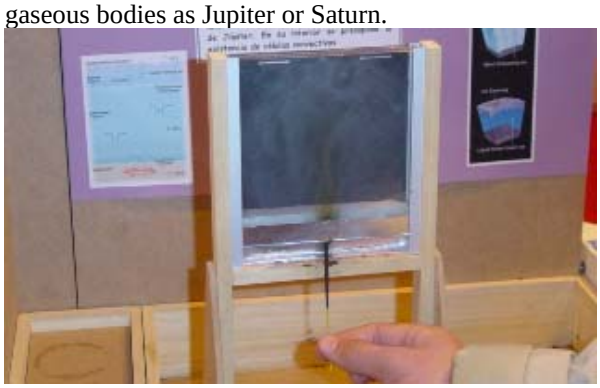

Fig. 2: novel experience for the modelization of convective processes of gases.

Magnetic field: the existence of a magnetic field in the Earth is very important for the development and maintenance of the life, as well as to protect the atmosphere and its composition. But the magnetic field of the Earth is not the only one existing in our solar system, neither so even the most potent [1] [2].

The modelization of the magnetic field lines is based on the known experiment [4] of iron filings distribution around a magnet. The improvement accomplished to such experience has been the overlapping to the magnet of a transparent plastic hemisphere on the one which are scattered the iron filings (Fig. 3). With this activity it is possible to observe the formation of new magnetic field lines, but in this occasion in three dimensions. This didactic activity is the perfect excuse for the explanation of the behavior of the magnetic fields existents in the Solar System.

Fig. 3: simulation of 3D magnetic field lines.

Orbital resonance: the orbital resonance processes are a common phenomenon in all the Solar System. The tides of the Earth or the intense volcanism of Io are two examples of the consequences of the orbital interactions between several planetary bodies [1] [2].

For the orbital resonances modelization we have been selected the example of the processes that are produced in the planetary system of Jupiter: the resonances between Jupiter and its satellites (Io, Europa and Ganymede). To illustrate these processes has been designed a mechanical dispositive that simulates the rotation of these satellites around Jupiter [5].

Impacts: if there is a common process to all the planets and satellites of the Solar System that is the impact crater formation, independently of the planetary surface: rock, ice or gas.

There are a lot of didactic activities oriented to the impacts modelization, but we employ a shooter mechanism that permits the variation of diferents factors as the incidence angle or the impact height [6]. With anyone of the employed modelization, this didactic activity permits to know how is produced the most common process of the Solar System, and to understand to all the planetary bodies form part of the same system and in the one which are found submitted to the same processes.

Volcanism: the volcanic processes defined in the Earth show its different faces in other planets and satellites [1] [2] [7] [8]. The criovolcanism of the icy satellites or the sulphur volcanism of Io are not more than variations of a same process responsible of the planetary surfaces renovation.

For the accomplishment of the simulation of the volcanic processes have been accomplished two experiments, the first one for the modelization of Hawaiian volcanic eruptions. This has been accomplished with the mixture of sodic bicarbonate and vinegar in a small recipient. In the second experiment has been simulated a plinian volcanic eruption through the mixture of dichromate of ammonium, magnesium and a little flame. In either case, the mixture containers were introduced in some clay models with the typical shapes of the volcanic Hawaiian and plinian volcanic edifices (Fig. 4).

Fig. 4: modelization of Hawaiian and plinian eruptions.

Conclusions: only some of the here analyzed didactic simulations are novel, but the employment of these for the explanation of some of the most common processes in the solar system is a novel didactic strategy. Moreover, the selections of these processes are not random and there are found mutually related. The convective processes are partially related to the existence of a planetary magnetic field. On the other hand, the convective processes, the orbital resonances and impact also could produce volcanic processes.

In any way, with these simulations intend to show the distribution extent of some of the processes that are studied in an isolated way for the Earth planet. Also it is shown the relationship between several planetary bodies and of the processes mutually. With these didactic activities can be shown the wealth and variety that keeps the Solar System.

Acknowledgements: this work was partially supported by CAM grants.

References: [1] Hartmann, W. (1993) *Wadsworth Pub. Comp*., Belmont. 510 p. [2] Beatty, J.K., Peterson, C., and Chaikin, A. (editors). (1999) *Cambridge University Press*. Cambridge. 326 p. [3] de Pater, I. and Lissauer, J. (2001) *Cambridge University Press*. Cambridge. 528 p. [4] Fardon, J. (1992) *Dorling Kindersley Lim*., London. [5] Martín, L. et al. (2004). *LPSC XXXV*, Abstract (this volume). [6] Martín, L. et al (2003) *LPSC XXXIV*, Abstract #1054. [7] Francis, P. (1993) *Oxford University Press*, New York 443 p. [8] Greeley, R. (1987) *Allen & Unwin*, Boston. 275 p.