FROM MADRID TO THE SKY: AN EXPERIENCE, OUT OF THE CLASSROOM, TO UNDERSTAND THE SIZE OF THE SOLAR SYSTEM. *Concha López[1], Miguel Ángel de Pablo[2,3], Gabriel Castilla[3]*. I.E.S. 'María Zambrano'. C/ Alpujarras, 52. 28915 Leganés, Madrid. Spain. [2]Área de Geología. Escuela Superior de Ciencias Experimentales y Tecnología. Universidad Rey Juan Carlos. 28933 Móstoles, Madrid. Spain. (depablo@geo.ucm.es). [3]Seminar on Planetary Sciences, Universidad Complutense, 28040 Madrid, Spain.

Introduction:

The textbooks represent the Solar System through pictures, but that offers us a distorted vision of the reality. The distances between the planets are of a great magnitude in comparison with their size. For this reason results very difficult to represent our planetary environment in a correct way. Consequently, if we want to make us an idea specifies of their magnitude we must accomplish different activities: paper models with the size of the planets to scale and representation to scale of the distance between the planets. Normally these activities should be accomplished separately due to the big difference between sizes and distances. In the activity that we present here we decided to join distances and sizes using as reference framework the most important streets and squares of the capital of Spain. We organize a tour on foot by the principal streets of Madrid in order to that the pupils transformed their city into a Solar System to scale.

Description:

This activity was developed with a total of 30 pupils of the subjetc of Geology of the Secundary School or High School (17-18 years old), within a didactic sequence on Planetary Geology that we have designed [2]. In order to approximate us to the distances, sizes, bulks and times to scale of the Solar System, we decided to depart of a reference framework known: our city.

Before the excursion the pupils calculated in the classroom the orbits of the planets on a plan of the city of Madrid. We locate the Sun in the square known as Puerta del Sol (Sun's Door), point where is located the kilometer zero of the Spanish highways net; and Pluto in a symbolic point of the outsides of the downtown area: Europe Door, in the Castilla square. As of these two frames of reference calculated and drew the orbits of the other planets in the plan. Once they located the orbits and knowing the distances of the planets Sun, the pupils calculated which was the scale of the Solar System that they had drawn, and calculated the diameter that to this scale would have to have the Sun and the planets. Finally, we draw on the plan the tour to follow in a line from the Sun's Door until Castilla Square, making to coincide the orbits of the planets with relevant places (statues, museums, buildings, etc.) of our city. In each one of these symbolic points the group of pupils was made a photo where was appearing the corresponding planet drawn to scale (Fig. *).

During the tour the pupils had to accomplish other two activities. It was requested that they calculated: which would be their weigh in each one of the planets [3]; and the age that would have a person that might have been born when they were in the Sun and that traveled in a commercial plane to 8.000 kilometers per hour with destination to Pluto [4]. The objective was: to compare bulks, compositions and distances using other reference frameworks also known and familiar for the pupils (their own weight and the speed of the plane). Finally, was them requested that indicated on the map of the city the limit of the Solar System.

At the end of the experience was accomplished a set in common where were elaborated the following conclusions:

a.- The planets are very small in comparison with the Sun.

b.- It is necessary to employ a high quantity of time to travel from one planetary bodies to other. Some pupils calculated the time that delays the light in being at the point the foreign Solar System and they remained impress by the cold as well as by the darkness that it must reign there.

c.- The huge distance between planets, that they had to go; and the progressive increase of the same.

d.- In the Solar System there is a high quantity of empty space.

e.- The limits of the Solar System are so far.

Conclusions:

This activity resulted highly positive. It served to begin the topics of the subject of Geology in a original way and to create an equipment spirit between the pupils. On the other hand for the accomplishment of this experience are needed very few material. Furthermore it is possible to relate this activity with other devoted to study features of the planets: impact craters [5,6], compositions [7],...When we present this didactic activity in a forum of secondary education teachers [8] it had very good acceptance. All this cause that we propose it to develop it in any city of the world.

References: [1] Estalella, R., *et al*. 1995. *Astronomía en la Escuela*. Colección Dossiers, Ministerio de Educación y Ciencia. Barcelona, Spain. [2] López, C.; Castilla, G.; de Pablo, M. A. *Retrato de la familia solar: una unidad didáctica de Geología planetaria.* Enseñanza de las Ciencias de la tierra; 10. 1. 41-46. [3] Hartmann, W.K., 1993. *Moons and Planets*. Wadsworth Publing Company. [4] Anguita, F. 1983. *El Sistema Solar y su exploración*. Anaya. Madrid, Spain. [5] Uceda, E., de Pablo, M.A., Fairén, A.G., Castilla, G. 2003. *Terrestrial impact craters: what can we learn about the Earth and other bodies of our Solar System?*. LPSC XXXIV (this volume). [6] Martín, L., López, C. Castilla, G., de Pablo, M.A. 2003. *Design and construction of an adjustable shooter for the modelization of impact craters in the classroom.* LPSC XXXIV (this volume) [7] Castilla, G., de Pablo, M.A., López, C. 2003. *Rocks and landscapes of the Solar System: an activity for the teaching abd divulgation of the Planetary Geology.* LPSC XXXIV (this volume) [8] López, C., Castilla, G., de Pablo, M.A. 2002. *La geología planetaria en educación secundaria*. Actas de los Foros de Experiencias 2002. Cosmocaixa, Madrid. 79-93.

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Fig. 1: Photograph of the poster about the activity elaborated by the pupils. It is shown the plan of the city of Madrid, Spain, with the orbits and location of the locations of reference where they were photographed with the planets to scale (see Fig. 2).

Fig. 2: Examples of the photographs accomplished in some of the locations of reference related with the orbits of the different planets. In the 'Puerta del Sol' (Door of the Sun) (left) it was made to correspond the location of the Sun, and it was the place where was begun this trip by the Solar System. In the 'Puerta de Europa' (Europe Door), in the square of Castilla (above), were located the orbit of Pluto, after a long travel for the streets of Madrid, Spain, our particular Solar System during a day.