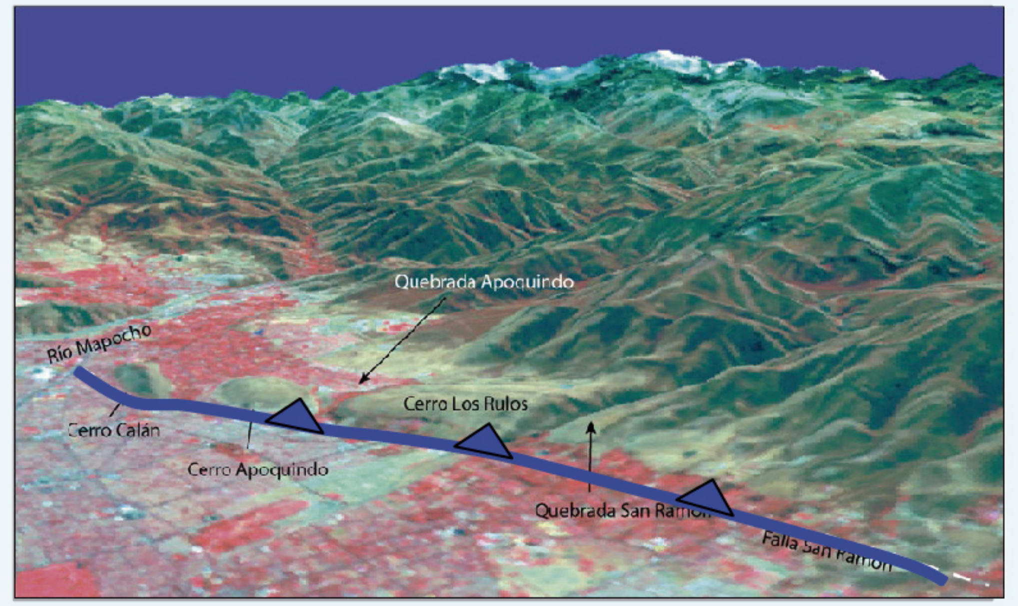
Universidad de Chile

fcfm Geología FACULTAD DE CIENCIAS FÍSICAS Y MATEMÁTICAS UNIVERSIDAD DE CHILE

DEVELOPMENT OF SPATIAL SKILLS THROUGH ANALOG MODELING OF TECTONIC DEFORMATION

Luisa PINTO, Departmento de Geología, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile, Email: lpinto@ing.uchile.cl.

SPATIAL SKILLS AT COLLEGE



Digital Elevation Model with superimposed satellite image and San Ramón Fault, Central Chile (Rauld, 2002), Principal Cordillera, Andes, 33º30'S.

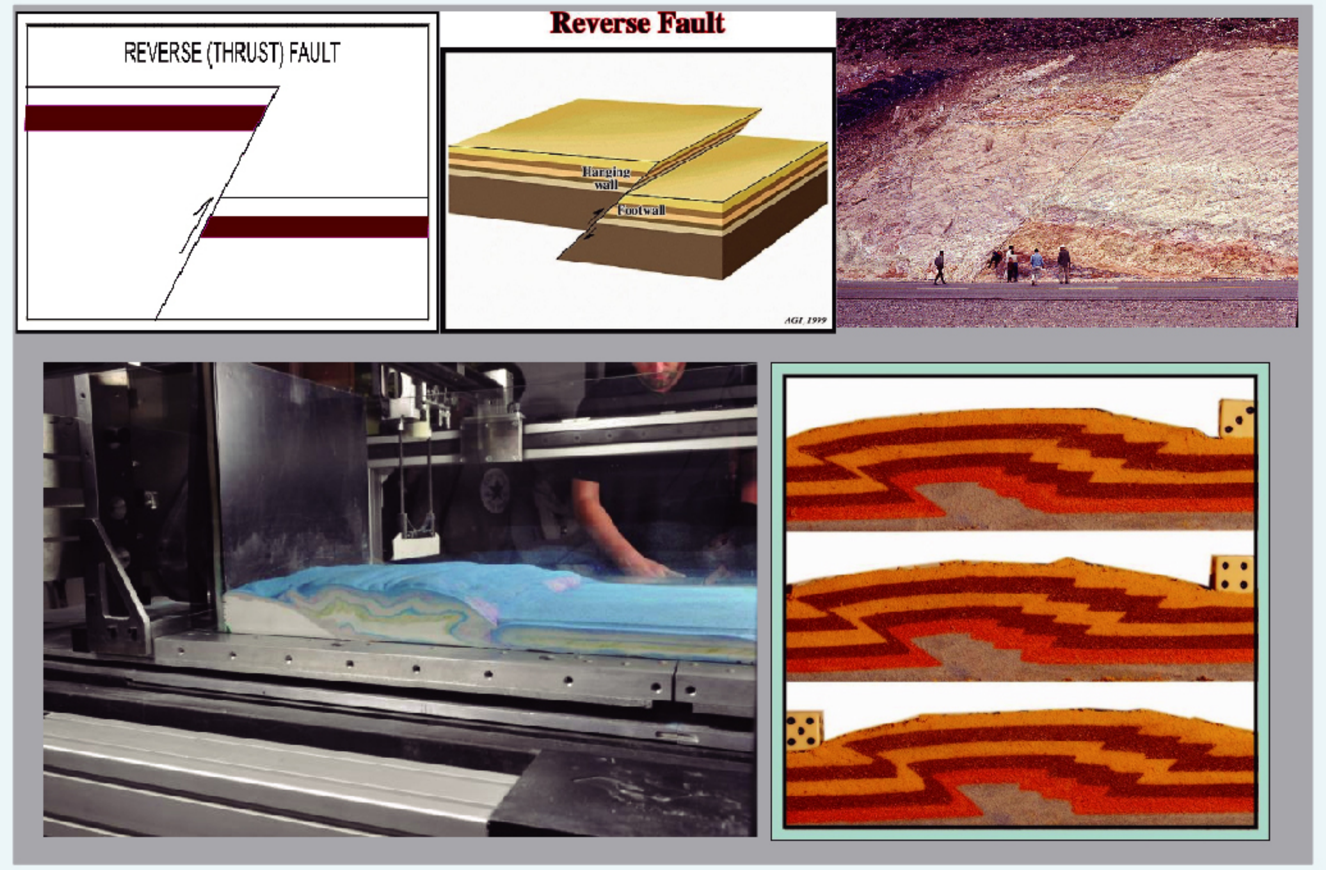
Understanding the formation of ranges and basins and its relation to structural geology, structural faults and folds in rocks is teaching to college students. In the case of the Andes Cordillera, these structures are contextualized to compressive tectonic in a subduction environment.

To enable students to understand the relationship between global tectonics, stress and generated structures, students must possess spatial skills. They must understand how the structures are projected in depth and how they vary three-dimensionally.

For this, classically mainly 2D and 3D schematic images are shown to them (figures up on the right) with standard geological symbologies. More recently, Digital Elevation Model with superimposed satellite images and outlining structures are used (figure left).

In courses of structural geology has been seen that college students have serious difficulties in understanding the geometries associated with different types of geological structures such as faults and folds affecting rocks. They mainly do not clearly visualize the sub-surface geometries. These difficulties in learning of spatial structures are related to teaching styles traditionally used. Normally profile images or diagram blocks are used, the field works are scarce or the structures have a regional scale, which prevents a proper understanding of the spatiality of them.

TEACHING TECTONICS AND GEOLOGIC STRUCTURES

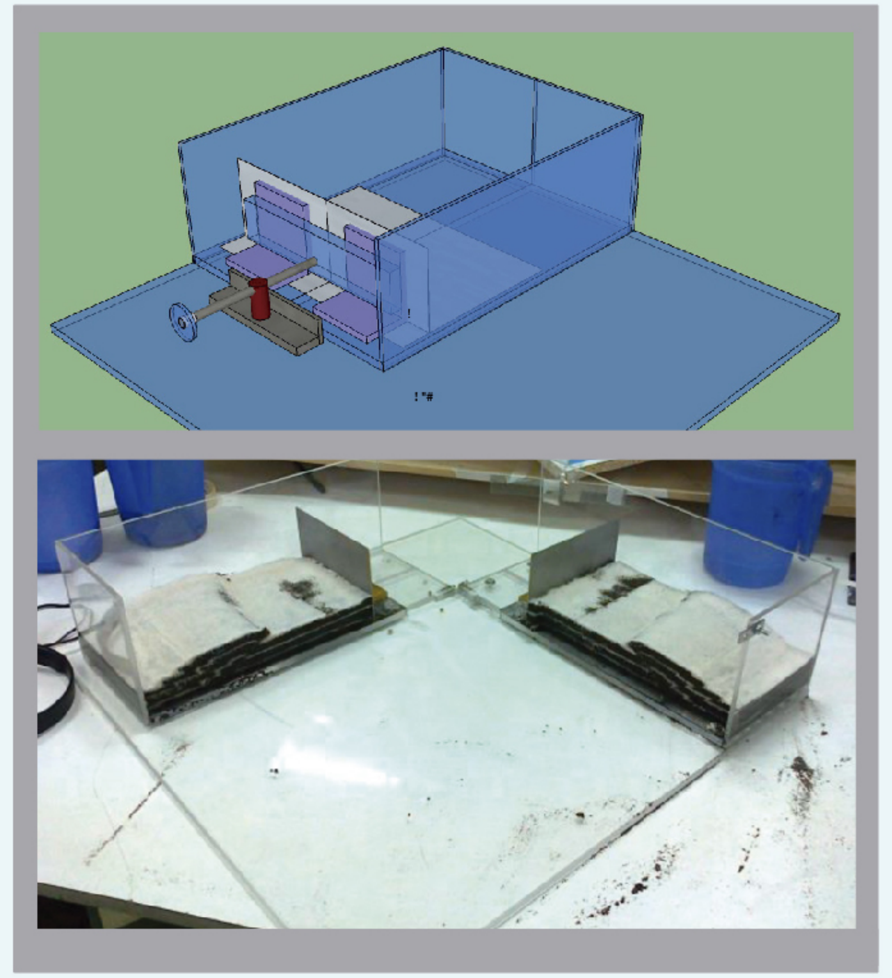


The most advanced teaching of structural geology is achieved in field campaigns (top on the left), where students are encouraged to understand the arrangement of the rocks and establish an evolution of deformation. However, if they do not have spatial skills, this task is very difficult to them.

The teaching experience in structural geology at college level suggests that the most effective ways of teaching spatial structures is achieved through the use of analog modeling. When the student performs analog models can actually visualize the 3D spatial relationship of structures in profile or 3D block plant in a laboratory scale.

One of the greatest problems of use this method of teaching in the classroom is to have simple and small devices in the case of large number of students. For a meaningful learning, students should work in small groups (4-5) making the model under the guidance of the teacher.

ANALOG DEVICE FOR TEACHING

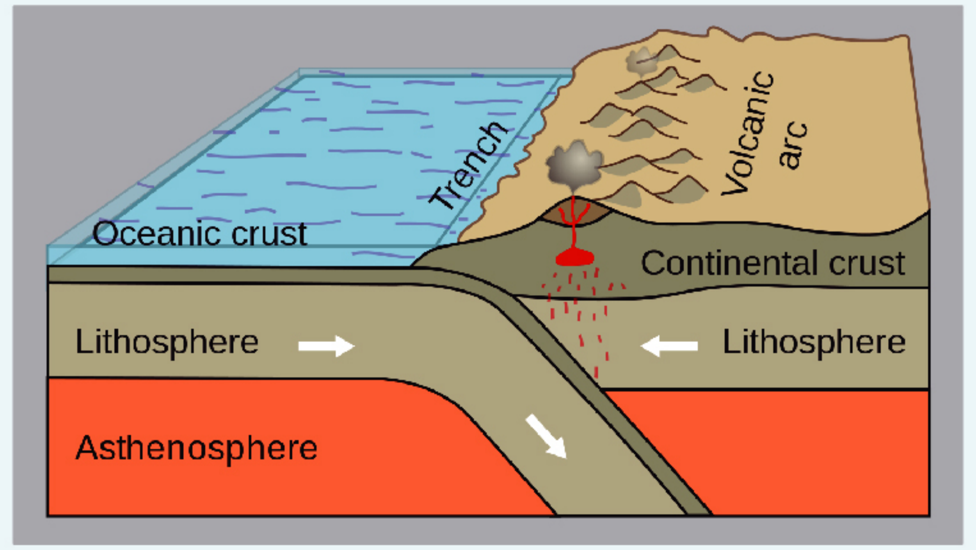


The tangible learning to develop spatial ability should begin in the school education to be intuitive in the higher education. Various topics of crustal deformation are part of the curricular bases of the school education in many countries, which are related to plate tectonics. However, the most of school teachers have not been adequately prepared to teach them.

That is why we have developed an analog device modeling adapted to the teaching of the compressive deformation of the upper crust for different levels of education, from school to college. The development of this device considers the generation of three prototypes that will be validated in the classroom to make the adjustments necessary for its improvement.

We present the results and validation of the first prototype (on the left), which consider a compressive tectonic, simulating the development of a range with double vergent structures. A sandbox is assembled at the interior of the device. The structures can be visualize easily through the translucide walls of the device, and on the top of the sandbox.

SPATIAL SKILLS AT SCHOOL

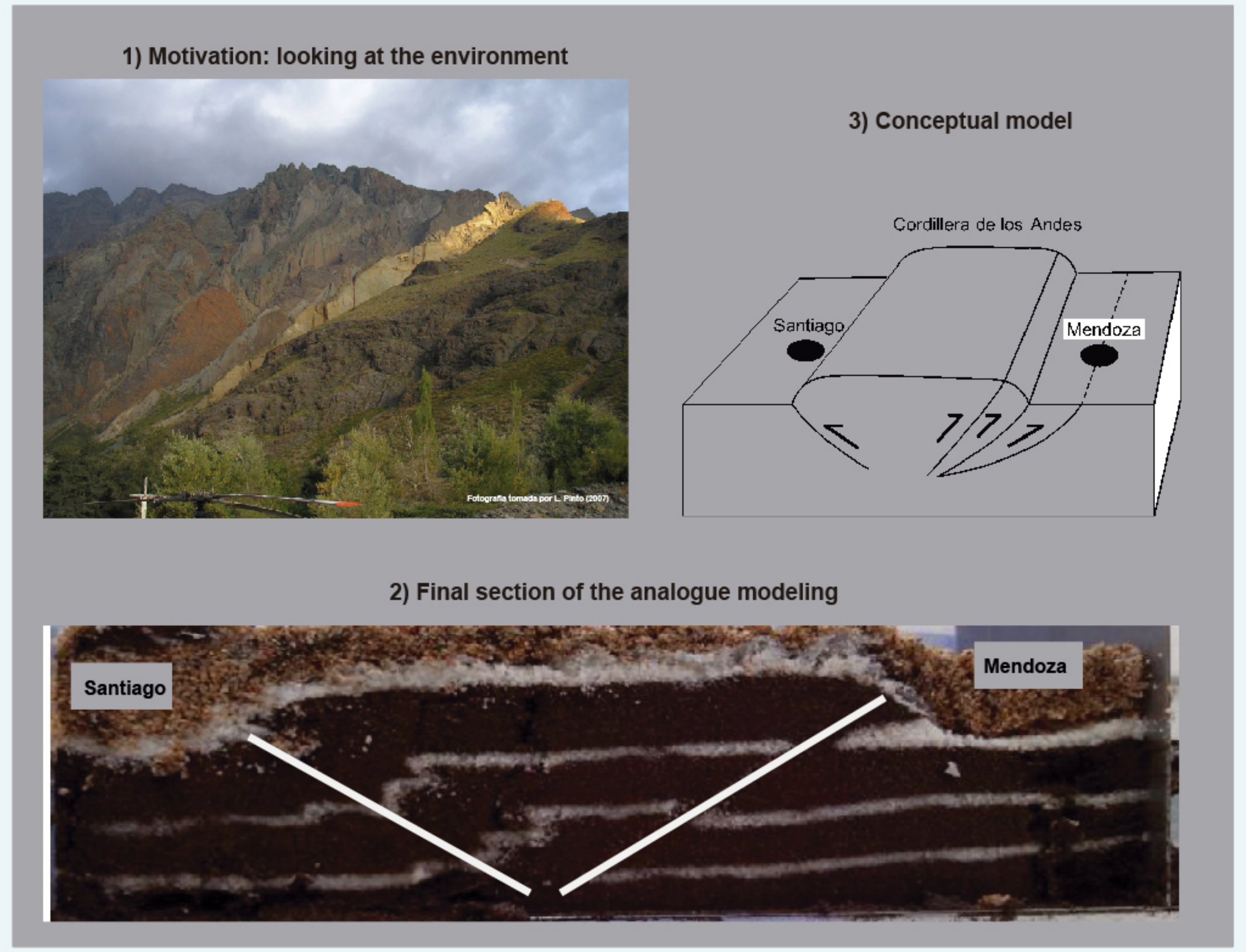


This is usually caused by a lack of teaching materials for school teachers, which can be used in their classes.

Our analog device for teaching purposes that simulates the deformation of the crust completes this gap. The device is capable of generating an elevation similar to a mountain range and also block structures like fault systems of most of the mountain ranges in the world (Andes, Himalayas, and Rocky Mountains) (conceptual model at the right).

The themes of geology taught in school correspond to plate tectonics, which depending on the level of teacher preparation is relatively well taught. However, the relationship of plate tectonics to surface processes such as earthquakes, deformation of rocks and volcanoes is not well understood in general. Topics of earthquakes and volcanism are closer to children in general, but the deformation of the rocks is a distant subject and is the least taught.

VALIDATION OF ANALOG MODELING



The first prototype has been validated: a) with children between 6 and 8 years; b) with school teachers of natural sciences, and c) with college students, from Santiago, Chile.

In the case of small children, from a Montessori school, the topic of plate tectonics had already been tried before the validation of analog modeling. Induction was done, going to the courtyard and looking at the mountains, to create in them the motivation to understand how it formed, how the rocks formed and how the fractures in the rocks were produced. Then, some slides of plate tectonics and deformed rocks of different ranges were showing. Then the children saw how the sandbox (simulating the earth's crust) was assembled in the analog device; they participated in the deformation thereof by compressing the device. Each child could look at the deformation that occurred at an intermediate stage before the final state, so they were heavily involved with the class. Finally, the sandbox got wet and cut to look the deformed sand at the center of the modeled range. This step impressed the kids watching what they managed to do. The school teacher treated the conceptual model as modeling developed.

For validation of the device with the school teachers, a demonstration during a training in geology was given. It seemed very helpful to them and they were motivated to use the device in their classes. For college students of Mining Engineering, it was possible to reach a little further work, analyzing the 'V' rule when cutting the sandbox at different angles.

RESULTS AND SECOND PROTOTYPE

PRELIMINARY RESULTS

Early results indicate that: a) the use of a device modeling causes great student motivation to learn; b) a contextualization of the deformation of the rocks regarding familiar processes for students as mountain building is needed; c) a meaningful development of spatial skills consider that the student should be able to look at the analog model from different angles; d) the student can also incorporate the temporal variable understanding the evolution of deformation in the event you can participate in the modeling process.

Validations helped visualize some adjustments to be made on the device. It was very big and heavy to transport, so it is being adjusted to a quarter of its original size, removing the base. Furthermore, the opening device is cumbersome so we are changing the cutting device by collapsible walls and, finally, ajusting a more accessible handle to compression.