

RETRACE-3D: CENTRAL ITALY EARTHQUAKES INTEGRATED CRUSTAL MODEL

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In the immediate aftermath of the August 24 2016 Amatrice earthquake, the challenging idea to develop a robust and broad consensus 3D crustal model of the area struck by the Central Italy seismic sequence led to blend in a synergic way the multi-disciplinary skills of CNR (IGAG and IREA), INGV and ISPRA (Servizio Geologico d'Italia). This coordination was actively promoted by the National Department of Civil Protection, of which these research institutes are Competence Centers.

On these premises, a new project has been set up as an operative research tool based on the best available geological, geophysical and satellite data and know-how, and on a shared and robust modeling workflow.

The project is called RETRACE-3D (centRal italy EarThquakes integRAted Crustal model). It has been designed working together, research institutes and Department of

Civil Protection, and formally defined by an Institutional Agreement among all the involved parties.

The main aims of the project are: i) to build up a high quality 3D model of the possible seismogenic sources in the crustal volume affected by the seismic sequence; ii) to define the 3D subsurface tectonic setting and distribution of the geologic units, which will contribute in its turn to improve the velocity models currently used to locate the seismicity, and to better understand the potential role played by structural features inherited from previous tectonic regimes; iii) to develop dynamic models of seismogenic structures through multiparameter optimization of ground deformations from remote sensing data; and, eventually, (iv) to provide the 3D crustal and velocity models as a support for the definition of the seismic input in the microzonation studies.

In order to achieve these ambitious results, the project involves more than 50 researchers (the *RETRACE-3D Working Group*) from the aforementioned Competence Centers. They will collaborate on voluntary basis in several tasks and benefit from a project repository created *ad hoc* to distribute and share data among the participants.

The study area, more than 4,000 km² wide, had been investigated for hydrocarbon exploration purposes through a large number of 2D seismic reflection profiles and a few wells. In the frame of the National Service of Civil Protection that, according to the Law 255/1992, also includes private organizations, these datasets were kindly provided by ENI and TOTAL oil companies, along with their expertise. Moreover, the same area is further covered by surface geological data (Geological Map of Italy at 1:500,000; 1:100,000 and 1:50,000 scale - ISPRA) already harmonized and codified according to a regional stratigraphic and structural scheme, as resulting from the activities of one of the project tasks. The input datasets also include velocity, gravimetry, magnetometry, tomography and Receiver Function data.

The interpretation of the available seismic reflection profiles will be carried out by several interpretation groups guided by the stratigraphic and structural scheme and codes, used as common keys previously defined by the tasks in charge for this, and constrained by surface data and well log stratigraphies.

The 3D modeling in time domain, the creation of the velocity model, the time-depth conversion and the integration with the gravimetry/magnetometry modeling will lead to a preliminary 3D crustal model.

All the possible different interpretations will be compared and reconciled in order to achieve a “broad-consensus” interpretation model for all the partners, which will be brought to the attention and discussed with the rest of the scientific community throughout dedicated public workshops and meetings specifically organized in the framework of the project.

This preliminary 3D geological model will be then extended to the depths of the whole 2016-2017 Central Italy seismic sequence exploiting and integrating further information coming from Local Earthquakes Tomography (LET), thermal and rheological data, and other geophysical studies carried out in those areas.

A following phase of geometric and kinematic validation (e.g., balancing and analogical modeling) and a cross-check against other datasets (e.g., SAR, GPS, coseismic surficial effects, seismogenic sources characteristics, Quaternary geology-geomorphology-neotectonics, seismic catalogues) that were not used during the first modeling phases will allow for the identification of possible inconsistencies and the general improvement of the geological model robustness. If necessary, the model will be further modified and refined to obtain a final 3D crustal model. This final model will also serve as a starting point for following geomechanical numerical simulations.

Due to the large community of researchers, private operators and institutions involved, the implementation of the *RETRACE-3D* project has been particularly challenging.

As a matter of fact, the expected main result, i.e., the development of a robust 3D crustal model useful for the scientific, professional and technical community, is only a part of the overall project outcomes.

The added value, we believe, is represented by the development of a multi-expertise coordinated working group, formally organized, in which the different teams operate in a harmonized frame to gain altogether a shared result. Being this result achieved in the frame of the Civil Protection field of interests, it has not only a scientific value, but also a societal one. Moreover, the large number of involved investigators from several research institutes makes the obtained result much more easily usable for civil protection purposes, representing not the idea of a single research group, but of a large and qualified community.

The Department of Civil Protection guarantees the equilibrium among the Competence Centers within the working group, allowing for a harmonized development of the activities and of the working flow. This organization represents therefore a “ready tool” that could be easily employed for the achievement of similar outcomes in others areas of our country.