



Annual Report* of IGCP Project No. 641

***NOTE: MAXIMUM LENGTH OF THE TEXT REPORT IS 5 (FIVE) PAGES (starting from question 1). SINGLE SPACE, 12 POINT FONT. REPORTS EXCEEDING THIS LENGTH WILL BE RETURNED TO THE AUTHOR(S) WITH THE REQUEST OF REDUCING THE TEXT TO THE ABOVE STANDARD.**

Send to UNESCO and IUGS
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by 01/12/2016

A LIST OF PUBLICATIONS HAS TO BE ADDED AS AN ANNEX.

The scientific information in this report will further be used for publication on the IGCP website hosted at UNESCO (please feel free to attach any additional information you may consider relevant to the assessment of your project).

IGCP project short title: Deformation and fissuring caused by exploitation of subsurface fluids

Duration: 4 years

Please tick this box if the report is for a Project on extended term (OET):

Project leader(s):





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Date of submission of report: 01/12/2016

Signature of project leader(s):

Leader	Signature
Dora Carreon-Freyre	
Devin Galloway	
Pietro Teatini	
Shujun Ye	

Annual Report**1. Website address related to the project**

<http://igcp641.org>

2. Summary of major past achievements of the project

- International network with more than 45 participants from nine countries.
- Special Session in the Ninth International Symposium on Land Subsidence, Nagoya, Japan, November 2015.
- First IGCP-641 Workshop at the Nanjing University, Nanjing, China, November 2015
- *Presentation of the project at the American Geophysical Union (AGU) Fall meeting, San Francisco, USA, Dec. 2015.*
H51A-1342: Mechanisms, Monitoring and Modeling Earth Fissure generation and Fault activation due to subsurface Fluid exploitation (M3EF3):
<https://agu.confex.com/agu/fm15/meetingapp.cgi/Paper/65232>.

3. Achievements of the project this year only**3.1. General scientific achievements**

- *We continued the characterization of the major ground-failure features in selected areas of Mexico City, Arizona and Nanjing and the integration of the methodologies developed by each leader and project participants to investigate the generation/propagation of earth fissure and fault activation.*
- *We continued to develop a global map of the distribution of ground failure caused by subsurface fluid extraction.*
- *We published scientific papers, gave oral presentations, Papers in Symposium Proceedings.*

3.2. List of IGCP project meetings/symposia and IGCP related meetings/symposia with exact attendance (if possible) and number of countries

- Annual Meeting held in Puerto Vallarta, Jalisco in Mexico
- Conferences in a Special Session during the Annual Meeting of the Mexican Geophysical Union in Puerto Vallarta, Jalisco in Mexico (40 attendees from 6 countries)
- XXVIII National Meeting of the Mexican Society of Geotechnical Engineering. November 23-25 2016. Merida Yucatán, Mexico. (250 attendees from Mexico)
- Session NH014: New Geophysical Methods for Understanding Geohazards in Urban Basins – AGU Fall Meeting 2016 – 12–16 December 2016, San Francisco, USA (potentially, 30 attendees from 9 countries?)
- Session H087: Remote Sensing Methods to Determine Vertical Land-Surface and Aquifer-Storage Change – AGU Fall Meeting 2016 – 12–16 December 2016, San Francisco, USA (potentially, 30 attendees from 9 countries?)

3.3. Educational, training or capacity building activities related to the IGCP project and IGCP project participants.

- 2nd International Workshop on Coastal Subsidence – May 30-June 1 2016, Venice, Italy.
- The Second Workshop was held during the Annual Meeting of the Mexican Geophysical Union in Puerto Vallarta, Jalisco in Mexico. November 2 2016. (24 attendees from 4 countries)

3.4. List of countries involved in the project (please *indicate the countries active this year and make the distinction between:

People's Republic of China (PRC), Mexico, United States of America, Italy, Spain, Poland, Philippines, Germany, United Kingdom.

3.5. Participation of scientists from developing countries, and in particular young and women scientists: exact number and please describe how this project specifically benefited women scientists, young scientists and/or scientists from developing countries

2nd workshop and Special Session	Total number of scientists	Number of male scientists	Number of female scientists
Number of participating scientists	40	17	13
Number of young scientists/students (<35 years old)	2	2	-
Number of scientists from developing countries	24	15	9

3.6. List of the 5 most important publications (including maps) of this year

Publications related to this project (with explicit acknowledgments):

- S. J. Ye, Y. Q. Xue, J. C. Wu, X. X. Yan and J. Yu, Progression and mitigation of land subsidence in China, *Hydrogeology Journal*, doi:10.1007/s10040-015-1356-9, 2016.
- Carreon-Freyre, D., Cerca, M., Ochoa-González, G., Teatini, P., Zuñiga, R., 2016. Shearing along faults and stratigraphic joints controlled by land subsidence and piezometric gradients in the Valley of Queretaro, Mexico. *Hydrogeology Journal*, doi: 10.1007/s10040-016-1384-0, 2016.
- Franceschini, M. Ferronato, C. Janna and P. Teatini. A novel Lagrangian approach for the stable numerical simulation of fault and fracture mechanics. *Journal of Computational Physics*, vol. 314, pp. 503-521, 2016. doi: 10.1016/j.jcp.2016.03.032.

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- Carreón-Freyre, D., González Hernández M., Martínez Alfaro D., Solís Valdez S., Vega-González M, Cerca M., Millán Malo B, Gutiérrez Calderón R., Alcántara Durán C.F., 2016. Análisis de la variación del índice de compresibilidad (Cc) de arcillas de origen volcánico en la ciudad de México. Memorias de la XXVIII Reunión Nacional de Ingeniería Geotécnica. Mérida Yucatán, México. 7 pp.
- Gutiérrez Calderón R., Alcántara Durán C.F., Carreón-Freyre, D., 2016. Incremento de la vulnerabilidad física por cambios geomorfológicos asociados a la subsidencia en Iztapalapa, Ciudad de México. Memorias de la XXVIII Reunión Nacional de Ingeniería Geotécnica. Mérida Yucatán, México. 5 pp.

3.7. Activities involving other IGCP projects, UNESCO, IUGS or others

Special Session organized with UNESCO-IHP Working Group on Land Subsidence during the Meeting of the Mexican Geophysical Union " Assessment of Land Subsidence processes in the world".

3.8. *Scientific Legacy: Is there a need for storage of publications, field data, and other results of the project? Do you have a clear vision concerning where the data would be stored and who will be the custodian?*

Yes, we have the need to store the input and output database of the project. We do not have decided which university or institution will be the custodian.

3.9. *What tangible improvements has your project obtained? (Besides publications, we are interested to hear about improvements to research, scientific contacts, policy implications, etc)*

We are making a strong exchange of methodologies by the analysis of specific study cases in different cities of Mexico, particularly in Mexico City, and in USA, Arizona. We are also working in the exchange of information to improve our databases and improve the impact of scientific publications and to disseminate the generated knowledge in technical meetings.

3.10. *What kinds of activities in respect to the benefit of society and science outreach has your project undertaken?*

We are working in the preparation of fact sheets and policy briefs for the awareness of the fracturing and faulting phenomena damaging urban infrastructure and housing in developing countries, like Mexico, where no public policies are establish to create prevention and mitigation measures.

3.11. *What kind of public information (media reports, etc) has your project generated? And how do you evaluate their impact?*

We continue to improve the website and are also using other social media such as LinkedIn and twitter for a better and faster communication to involve more participants from different countries. They cannot yet be evaluated.

4. Activities planned

4.1. General goals

- Continue to enlarge the M3EF3 participant network
- Publish a summary of the field trip associated to the annual IGCP-641 workshop in Episodes. The contribution " The impressive ground ruptures in Jocotepec, Mexico, due to groundwater pumping: the 2016 field excursion of IGCP-641" will be submitted by the end of 2016.

- Continue the integration of a map of worldwide occurrence of ground failure with related metadata.
- Publish the improvement of the characterization and modelling methodologies in scientific papers.
- Disseminate the results of our research work mainly in developing countries.

4.2. Tentative list of specific meetings and field trips (please list the participating countries)

- First International Conference on Urban Geology in Shanghai, China in April 2017.
- Annual Meeting of the Mexican Geophysical Union which will have "Geological Hazards and Risks" as main topic in 2017.
- Annual Meeting of the M3EF3 IGCP participants in Spain.

5. Project funding requested

\$ 10,000.00 USD

6. Request for extension, on-extended-term-status, or intention to propose successor project

N/A

7. Financial statement (\$ USD only)

The IGCP Scientific Board would like to be informed how the IGCP funds were used.

We need to use at least \$6000 USD to effectively support transportation/hotel fees of two or three participants from developing countries, that in the most of the cases do not have funds for travelling to other countries.

\$ 3000 USD for the organisation of the third IGCP 641 workshop, probably in Spain, and \$1000 USD for general expenses.

8. What additional funding besides the IGCP seed funding has your project obtained thanks to the IGCP label? Please estimate the budget received for meetings, research or other and identify the source.

A project supported by the National Center of Disaster Prevention (*Centro Nacional de Prevencion de Desastres, CENAPRED*) has been recently approved to Dora Carreon-Freyre to assess the land susceptibility to fracturing associated to groundwater withdrawal in Mexico City. A detailed map of earth fissures, fractures and faults will be developed and improved with the collaboration with the M3EF3 IGCP Participants.

9. Attach any information you may consider relevant

We are attaching a compressed folder including ten files to this report:

- A general description of the 2nd workshop and fieldtrip held in Jalisco, México, with photographs,
- Four grateful letters from students and young researchers for the support given by the 641 IGCP project,
- Three papers, one scientific paper and two proceedings papers with explicit acknowledgement to the project,
- A file with an example of the certificate of the attendance for the students that participated in the 2nd IGCP workshop,
- A file with a letter of appointment from the Ministry of Land Resources from China to Dora Carreon-Freyre as a member of the academic committee of the key Laboratory of Land Subsidence. Monitoring and Prevention from 2016 to 2021.