Geospatial Research Ltd.

Integrated Geoscience from Field, Satellite and Map Data

Quantitative Characterisation of Fractured Jurassic and Triassic Reservoir Units, Kurdistan

Product Summary

Containing a suite of quantitative fracture parameters that are comprehensively constrained using the best outcrops of Jurassic and Triassic reservoir analogues from across the Kurdistan Region of Iraq, this product provides direct inputs for improved fracture modelling. Detailed outputs are derived from our multi-scale fracture characterisation, using data acquired during 221 collective field days in November 2013 and May 2014, followed by thousands of hours of processing by our fracture teams in Durham.

Fracture parameters are constrained by:

- Detailed field survey from 159 high quality exposures of Jurassic and Triassic reservoir units (see Table below), from northern, central and southern Kurdistan.
- Field acquisition using a combination of traditional and modern data collection methods, including 1D measured transects, lidar laser-scanning, and 3D digital photogrammetry.
- Hand samples, biostratigraphic age dating, and petrographic study of thin sections.
- Detailed litho-stratigraphic logs, with accompanying gamma ray and mechanical hardness (Schmidt hammer) measurements, to help correlate the outcrops with corresponding units in the sub-surface.

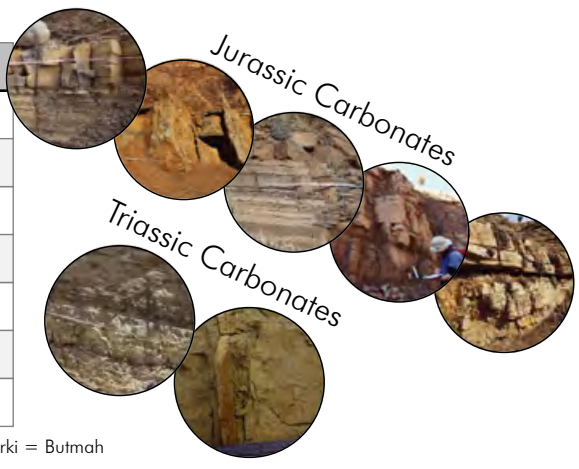
The fracture parameters are interpreted within the context of our wide-ranging outcrop to regional-scale knowledge of deformation styles and mechanical properties of Zagros stratigraphy, to derive a Conceptual Fracture Model (CFM) for each Jurassic and Triassic reservoir formation.

Pricing

- Single company, corporate license: Price on Application

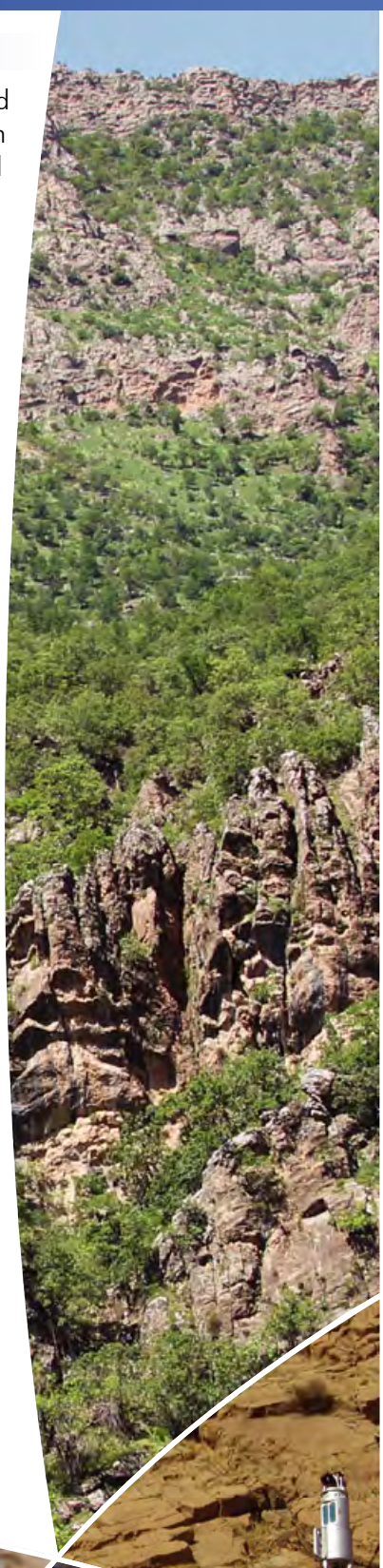
Licenses permit use for 25 years and are non-transferable. Licensed data are strictly for use by bona fide employees of the named licensee companies, and cannot be shown or passed by any means to other companies or organisations, other than in accordance with the terms of the license agreement.

	Formation	Number of study sites
Jurassic	Chia Gara	4 FTM, 1 PG
Jurassic	Barsarin	9 FTM, 3 PG, 1 TLS
Jurassic	Sargelu	15 FTM, 4 PG, 2 TLS
Jurassic	Sehkaniyan *	46 FTM, 11 PG, 5 TLS
Jurassic	Sarki *	16 FTM, 3 PG, 1 TLS
Triassic	Kurra Chine	29 FTM, 6 PG
Triassic	Geli Khana	3 FTM



* Names used in the sub-surface: Sehkaniyan = Alan-Mus-Adaiyah; Sarki = Butmah

Table: Summary of included fracture data. FTM = Fracture transects measured manually from outcrop. PG = photogrammetry study. TLS = Terrestrial Laser Scan (Lidar). PG and TLS produce 3D copies of the outcrop, from which detailed fracture measurements can be derived. In addition to these 159 study sites, we also include 23 logged sections measured from key locations across Kurdistan.



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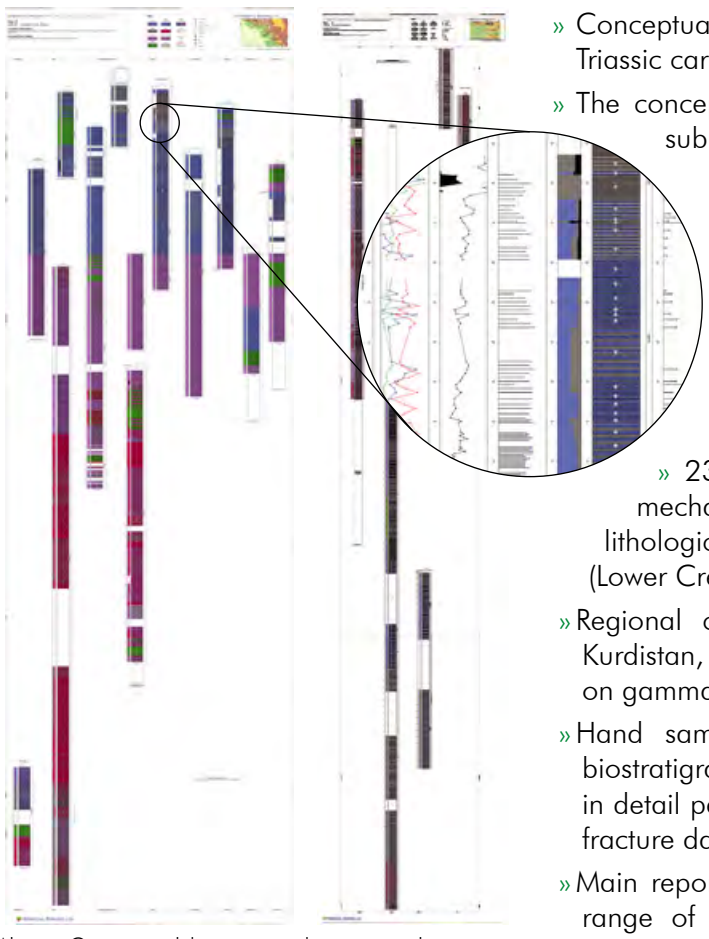
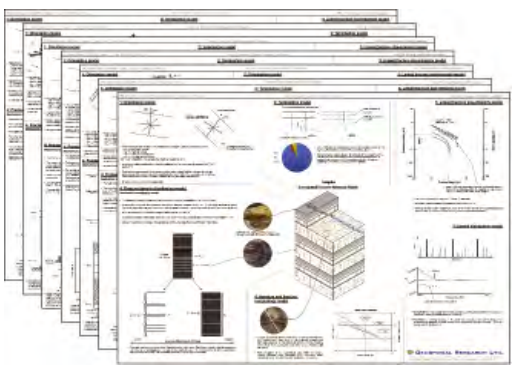
Product Contents



Above: Composite litho-stratigraphic outcrop logs span Lower Cretaceous (Chia Gara), through Jurassic to lower Triassic (insert shows detailed log section).

- Conceptual Fracture Network Models (CFM) for all major Jurassic and Triassic carbonate reservoir units.
- The conceptual fracture network models are described in terms of six sub-models: the data from this project will help to describe in detail the orientation model, termination model, linked fracture size-intensity model, density distribution model, and spatial distribution model. We also give some insight into fracture apertures and morphology.
- Raw fracture data and field photos from each of the 159 study sites. All information is georeferenced and catalogued for easy access, and has associated metadata to enable the data to be appropriately risked by each client.
- 23 logged outcrop sections combining gamma ray (K-U-Th), mechanical hardness (Schmidt hammer), fracture intensities, lithological descriptions, and locations of samples, from Chia Gara (Lower Cretaceous) to Beduh (Lower Triassic).
- Regional correlation panels to link northern, central and southern Kurdistan, and to correlate surface outcrops with the sub-surface, based on gamma ray and litho-stratigraphic logs.
- Hand samples from 47 locations, of which 27 have undergone biostratigraphic analysis by RPS Energy. All samples have been assessed in detail petrographically to correlate the logged section and associated fracture data to the subsurface.
- Main report providing an overview of the data and a summary of the range of values of derived fracture characteristics per stratigraphic formation, together with comprehensive Appendices containing full fracture data, petrographic descriptions and biostratigraphic analyses.



Above: Summary plates for each formation detailing the Conceptual fracture Model. Right: Report and accompanying appendices with all supporting data.

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About Us

Who we are:

- Geospatial Research Ltd. (GRL) is an independent company with close links to Durham University.
- We produce **integrated geoscience** solutions from field, satellite and map data to inform sub-surface interpretations.
- Our core expertise is **structural geology, tectonics** & **geodynamics**. We have extensive experience of deriving quantitative **fracture parameters** from outcrop to satellite scales as input for fractured reservoir modelling.
- We have a collective experience of **more than 10,000 field days** across five continents, and we are engaged in commercial projects spanning most of the world's petroleum provinces.

Zagros specific experience:

- Extensive field experience in the Middle East, particularly the northern Zagros. We have carried out a total of **24 successful Zagros fieldwork campaigns**, totalling many hundred field days, in over 40 license blocks, for **14 companies** since 2009.
- Close collaboration with colleagues in Durham University with wide experience of the **Iranian Zagros**.
- Regional mapping expertise for the entire Zagros based on interpretation of **satellite data**.
- Balanced cross-section construction for regional and detailed anticline studies – we have constructed **143 sections totalling more than 6,800 km**.
- Detailed outcrop knowledge of **Cambrian-Pliocene stratigraphy**.
- Very extensive work to **characterise fracture systems** in Cenozoic & Mesozoic reservoirs.
- Proven capability of producing Zagros-wide **geological maps, cross-sections** and **geodynamic interpretations**.

GRL Contacts

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