A Collaborative Investigation of the Johnston Atoll Marine National Monument: Results from R/V *Falkor* Mapping Cruise FK161229 (12/29/2016 – 01/16/2017)

Dr. John R. Smith, University of Hawai'i/SOEST

Recent seafloor mapping and ROV telepresence-enabled expeditions to several of the U.S. Marine National Monuments in the Pacific Ocean have received great attention by the research community, school groups, and the general public. The NOAA Ship *Okeanos Explorer* (EX) and her ROV *Deep Discoverer* (D2) carried these out as part of NOAA's Office of Ocean Exploration's CAPSTONE campaign, a collaborative effort to explore the deep waters of these monuments with support from other NOAA programs. One of these areas, the Johnston Atoll Unit (JAU) of the Pacific Remote Islands Marine National Monument (PRIMNM), is the focus of this proposal. The JAU was expanded from a radius of 50 nm centered on the atoll to the full 200 nm Exclusive Economic Zone (EEZ) in 2014 and now encompasses a vastly greater number of seamounts and ridges. Even with two dedicated EX cruises in 2015 and an Extended Continental Shelf (ECS) mapping cruise to the area in 2014, much of JAU had not been mapped or explored prior to the *Falkor* cruise. The JAU lies in the midst of the Prime Crust Zone (PCZ), an area of the Pacific with the highest expected concentration of deep-sea minerals, including economically valuable metals and rare earth elements. We also know the region harbors high-density deep-sea coral and sponge communities, with some unusual creatures presently under study that were video-documented and/or sampled during 11 dives by D2 in 2015. Thus, any further data collection in this hard-to-get-to region represents an enormous opportunity for scientific research, undoubtedly leading to new discoveries in an ecosystem that is largely isolated from human perturbations. There remain many seamounts and related features to map.

Multibeam mapping within the Johnston Atoll Unit (JAU) of the Pacific Remote Islands Marine National Monument (PRIMNM), was the focus of this project using R/V *Falkor*. The objectives were to carry out multibeam mapping and magnetics surveys, provide the fully processed data to the research community and public, synthesize it with pre-existing data in the region, and produce derived products including interpretative geologic and structural maps along with substrate analyses necessary for geologic study, habitat characterization, and mineral resource evaluation. The plan was to map as many seamounts in the southwestern portion of the JAU, known as the Johnston Seamount Group, as the available time would allow. Seven seamounts of various sizes were surveyed in approximately 5.5 days on site, corresponding to a mapped area of 11,241 km^2, which does not include the two weeks of transit data.

Interpretative geologic maps have been completed since the cruise ended in January 2017, along with preliminary interpretation of the magnetics data, both efforts carried out by Jonathan Tree, my Marine Geoscience Data Technician. We presented our results at The Geological Society of America (GSA) Cordilleran Section meeting that took place in Honolulu in late May 2017 (see abstract on next page). Our efforts will continue in merging the *Falkor* data with the pre-existing data and we also plan to prepare a manuscript for publication within the coming months. Derived products in the form of bathymetry/backscatter grids have already been made available to the various interested NOAA groups including the PRIMNM office, the Coral Reef Ecosystem Program, and the office of Ocean Exploration and Research for an upcoming *Okeanos Explorer* cruise. This cruise will most likely target some of the seamounts we mapped with ROV dives, along with additional mapping of neighboring seamounts. All the raw and processed data have been delivered to the R2R and MGDS programs at Lamont-Doherty Geological Observatory to be made available for download by the public and the wider research community.

Following is the paper that was presented at the GSA meeting on May 25, 2017 in Honolulu:

Geological Society of America, Cordilleran Section - 113th Annual Meeting - 2017
Paper No. 44-5

DETAILED GEOLOGIC MAPPING EXPOSES COMPLEX ERUPTIVE HISTORY AND FUNDAMENTALLY DIFFERENT RELATIVE AGES OF NEWLY SURVEYED SEAMOUNTS WITHIN THE JOHNSTON ATOLL UNIT OF THE PACIFIC REMOTE ISLANDS M.N.M.

TREE, Jonathan Patrick, SMITH, John R., MILLER, Joyce, all at University of Hawaii at Manoa, 1000 Pope Road, MSB 205, Honolulu, HI 96822 and KANG, Andrew, Marine Laboratory, University of Guam, Mangilao, 96923, Guam, jtree@hawaii.edu

During the FK161229 expedition, Schmidt Ocean Institute's *R/V Falkor* embarked on a scientific transit-cruise en route from Guam to Hawaii. The goal of the cruise was to map geomorphic and subsurface seamount structures within the newly expanded Johnston Atoll Unit (JAU). The cruise collected over 11,000 km^2 of high-resolution multibeam data within the targeted survey area. A detailed geologic map was illustrated that differentiates between volcanic, sedimentary, and erosional units of the seamounts. The unit contacts were drawn using morphological relationships observed from 20-meter bathymetric and 5-meter backscatter resolution grids. Structural relationships were mapped including individual volcano-specific contacts, numerous landslide scarps, faults, and paleoshorelines. Along-track magnetic data show contrasting magnetic anomalies designating two main relative ages of emplacement for these seamounts. These new maps reveal additional complexities of a previously assumed simplistic model of volcanic growth. At least ten individual volcanoes built the four seamounts surveyed, a constructional evolution similar to that of the Hawaiian volcanoes. The high-quality data display the detailed nature of the contacts between these volcanoes and show multiple periods of subaerial growth. The subaerial regions with flat or gradually sloping carbonate and sediment-capped summits are present at three main depth ranges, indicative of three different subaerial growth durations. Numerous post-erosional monogenetic cones that erupted through the carbonate caps are the most notable features of the summit morphology. Over 50 individual summit volcanic cones were identified. A post-subsidence, submarine emplacement of the summit cones is hypothesized due to the preservation of the cones' smaller size and location where subaerial erosion could have easily erased these features from the geologic record. These features are also observed on the summits of other seamounts within the JAU seamount group. The frequency of occurrence of summit cones on JAU volcanoes suggests that the eruptive mechanism generating the cones has been long-lived throughout the formation of these seamounts and differs from the equivalent rejuvenated stage of Hawaiian volcanoes.

The geological and structural interpretative maps for four of the six seamounts studied in this project are included on the following pages as an example of the products we have prepared and to show what was presented at GSA. To place our interpretations in context, we also include data layers. In this case, the layers consist of shaded and contoured multibeam bathymetry and backscatter grids at 20-meter cell spacing. The first feature shown here is Pierpont Seamount (*proposed name*), located near the southwestern edge of the JAU boundary. It exhibits a classic stellate shape of an ancient seamount, with five to six radiating rift zone ridges and landslides or debris flanks in between. Summit blow-ups are also included, showing the detail of the flat-topped feature, commonly referred to as a guyot or tablemount, with numerous secondary volcanic cones distributed around the top. As you will see, most of the seamounts mapped for this project display the same or a similar morphology and geological units, although some are far more complex with multiple major eruptive centers and a more varied distribution of units.

Johnston Atoll Unit of the PRIMNM
R/V Falkor mapping data from FK161229 with proposed seamount names

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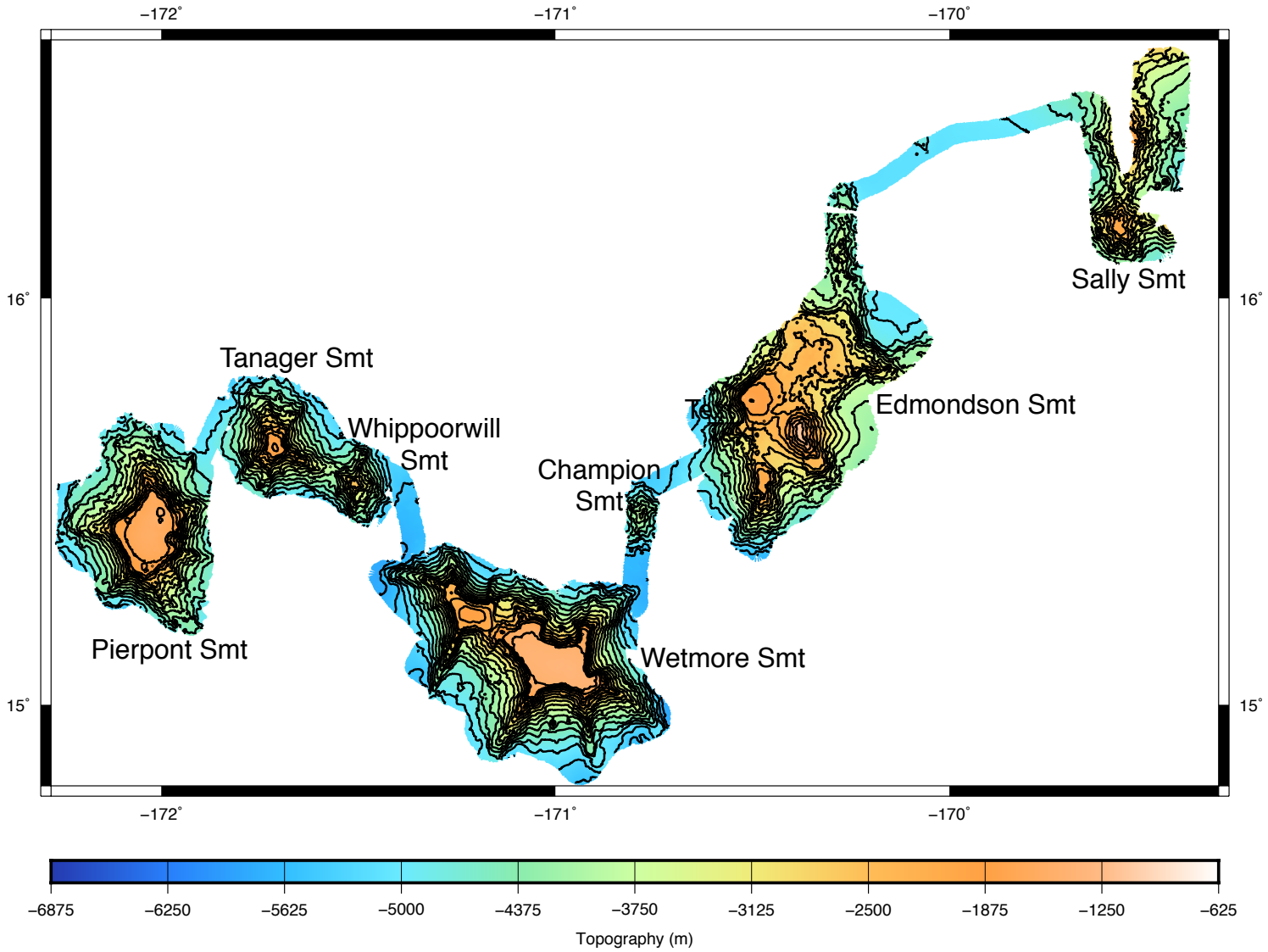

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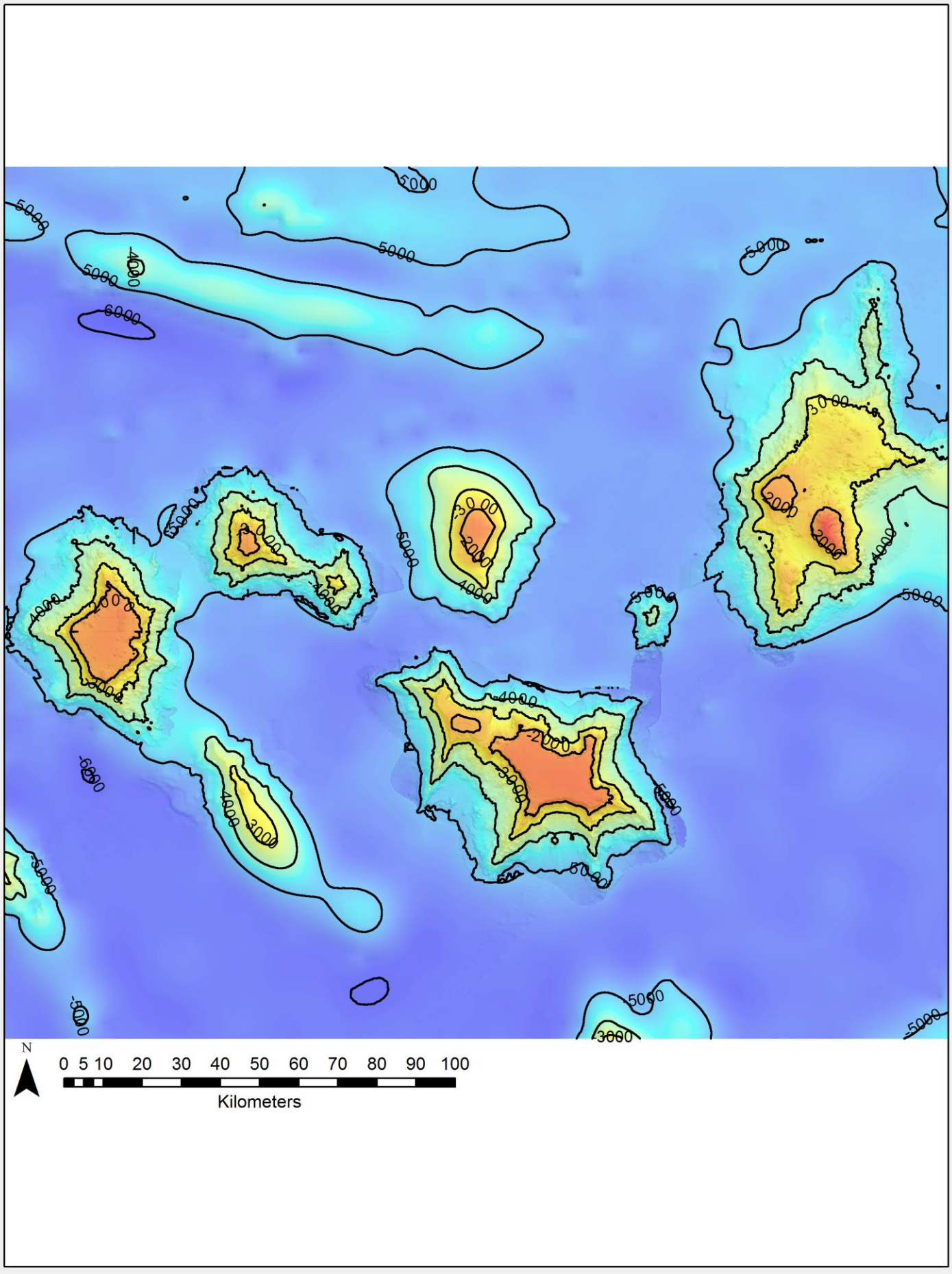

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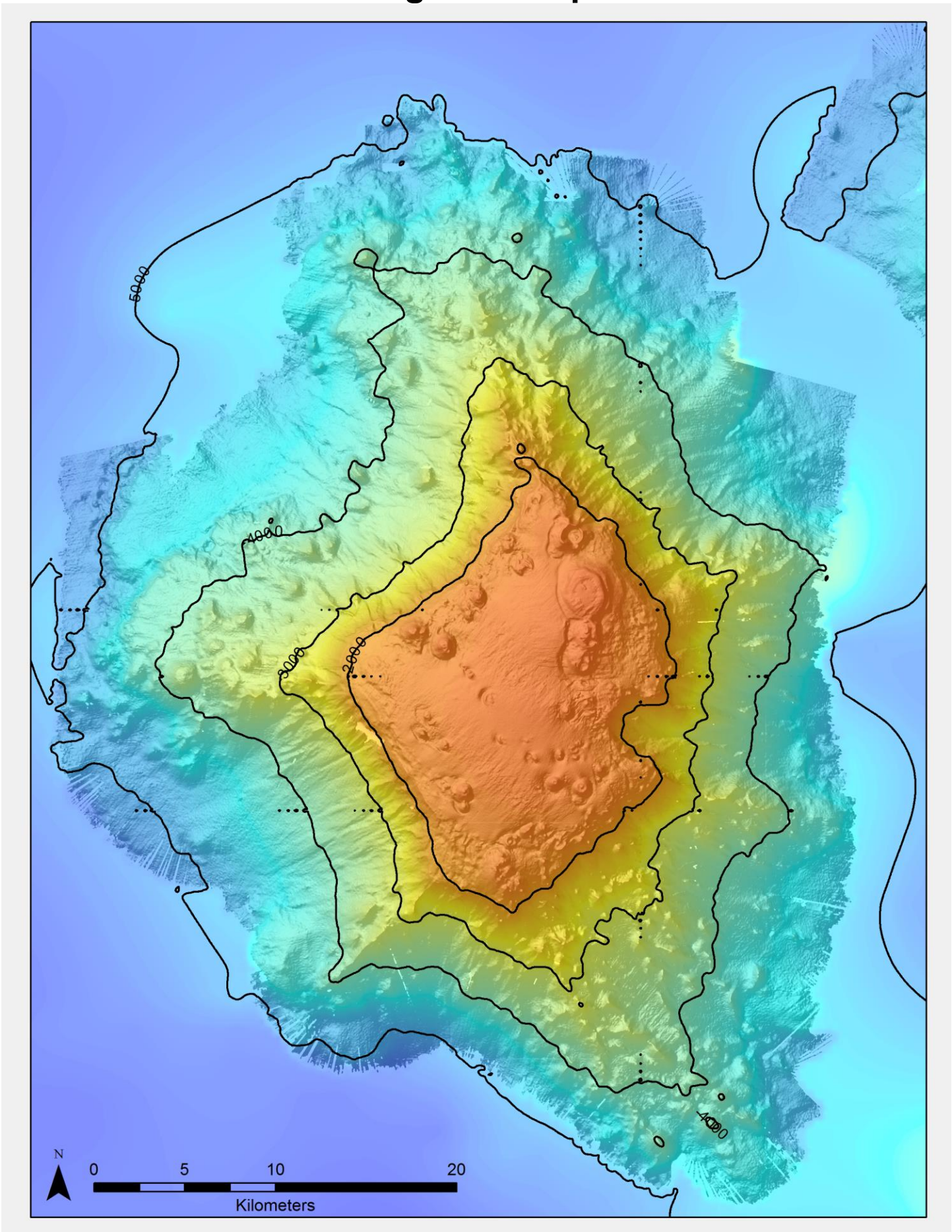

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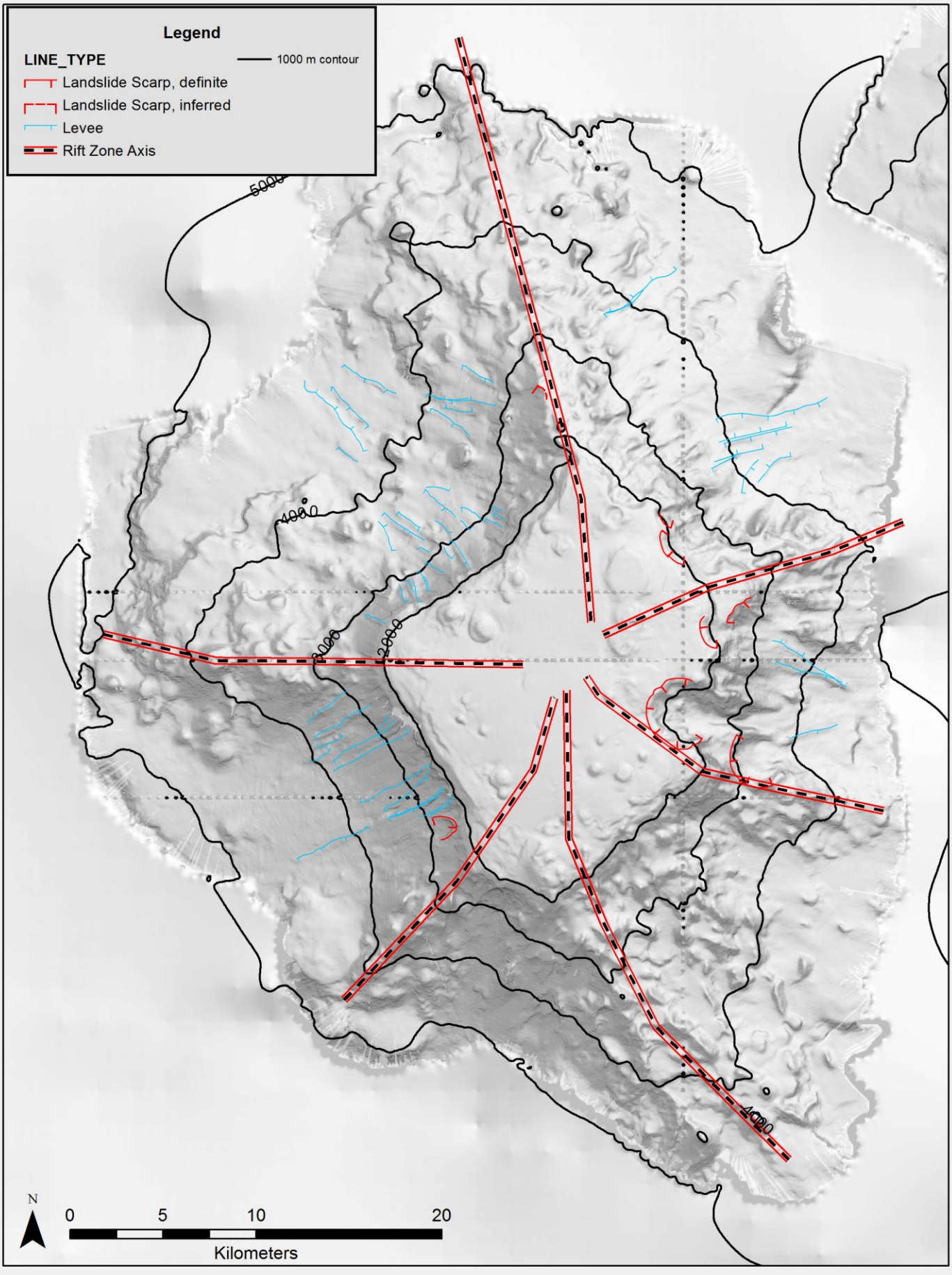

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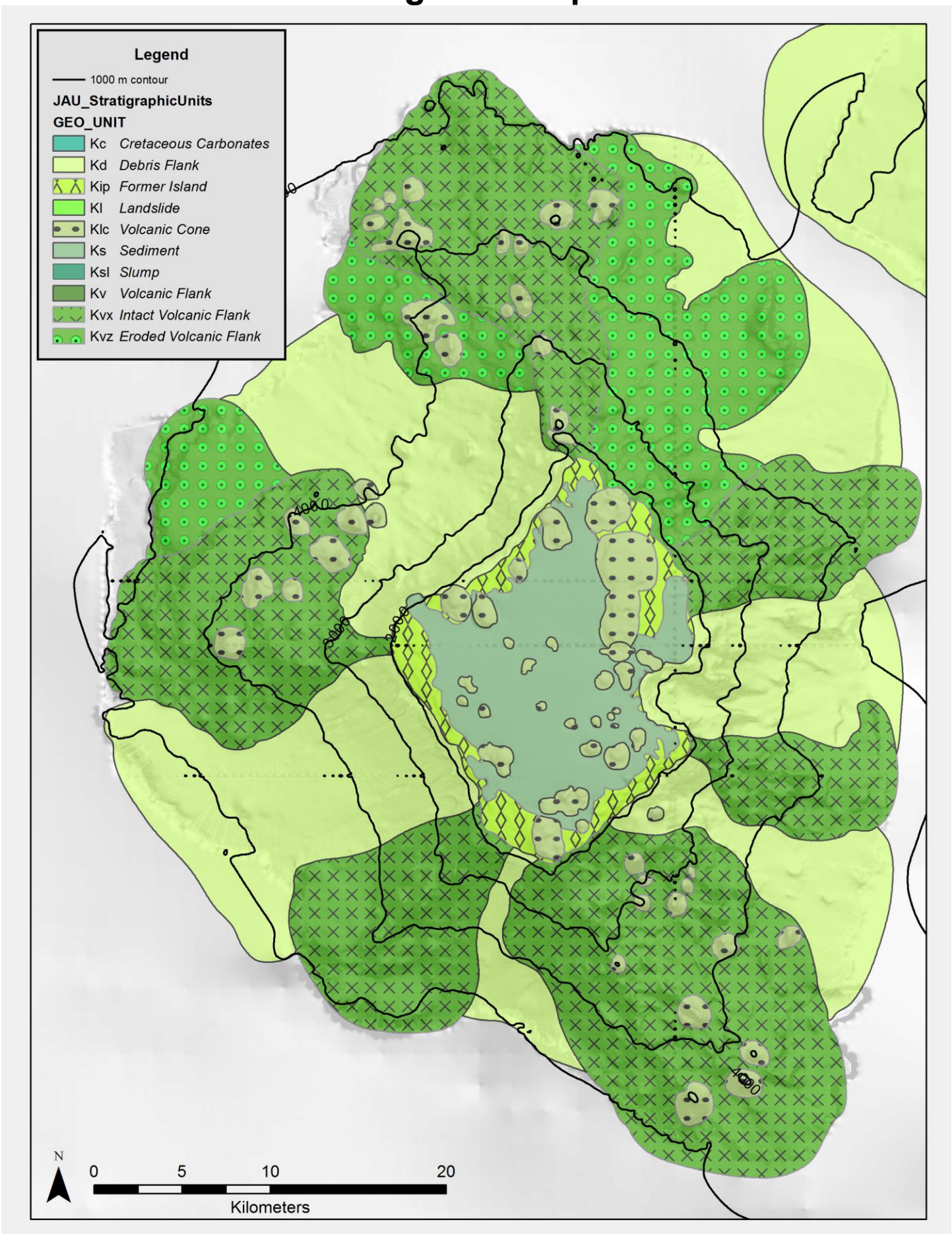

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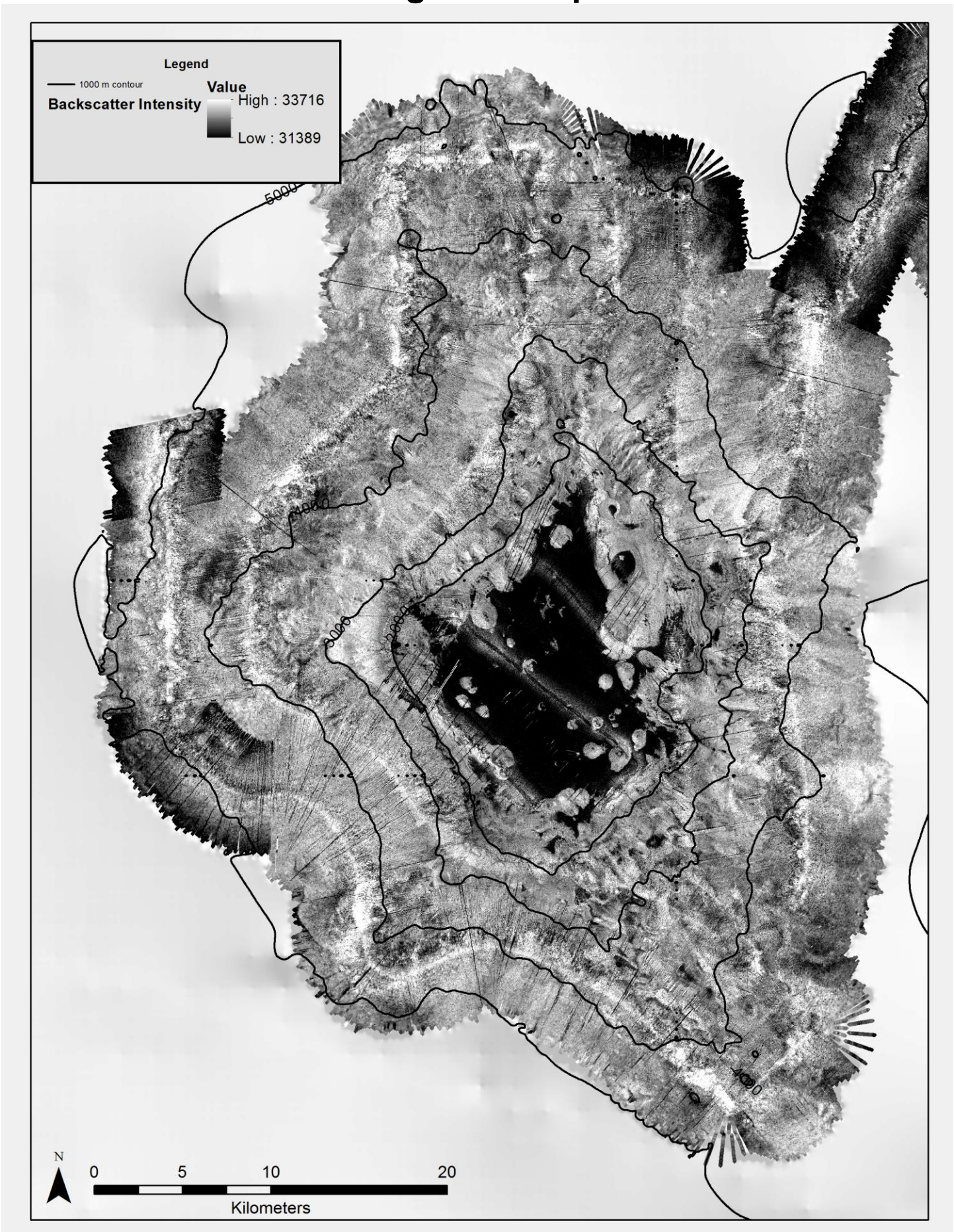

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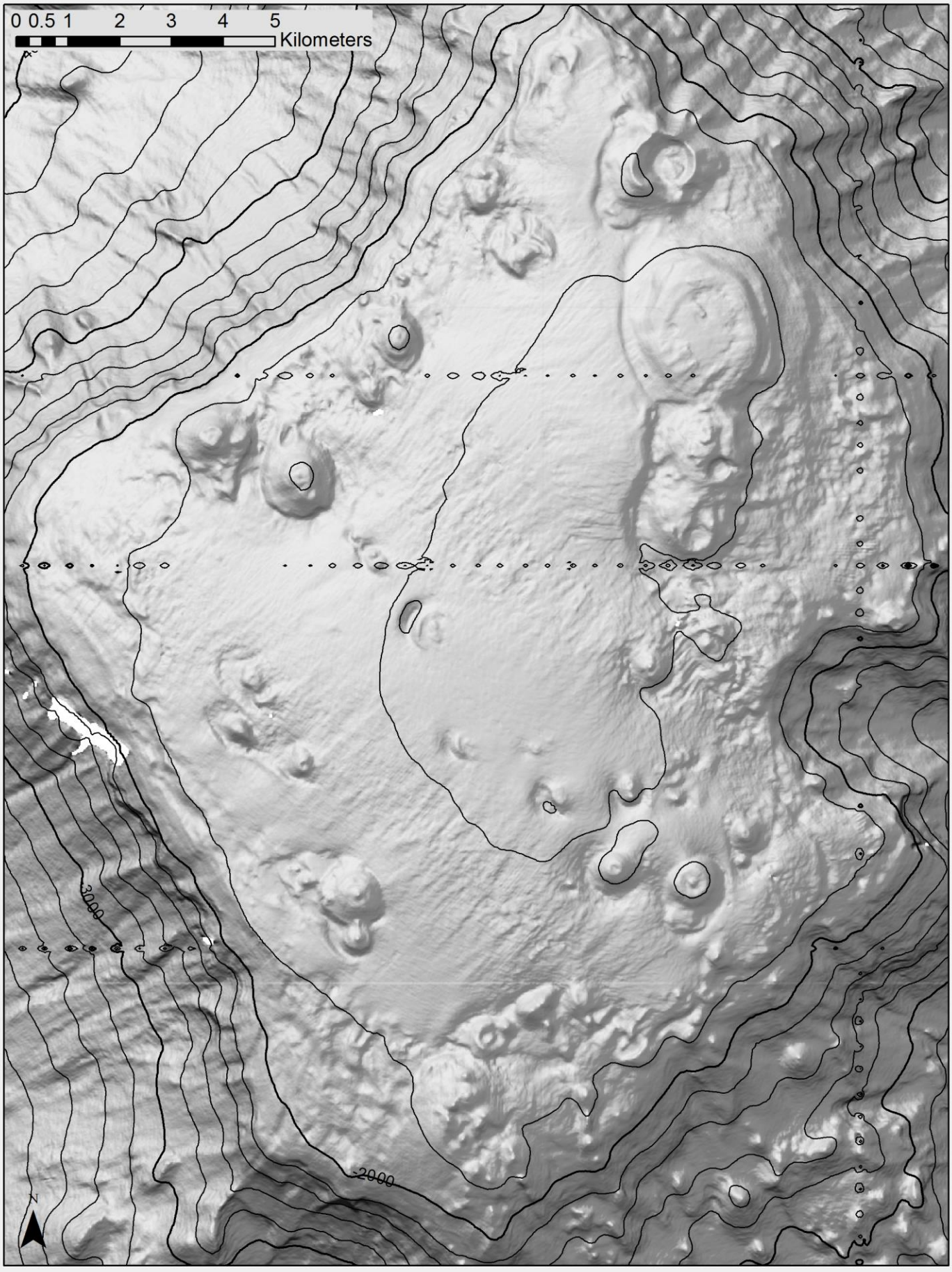

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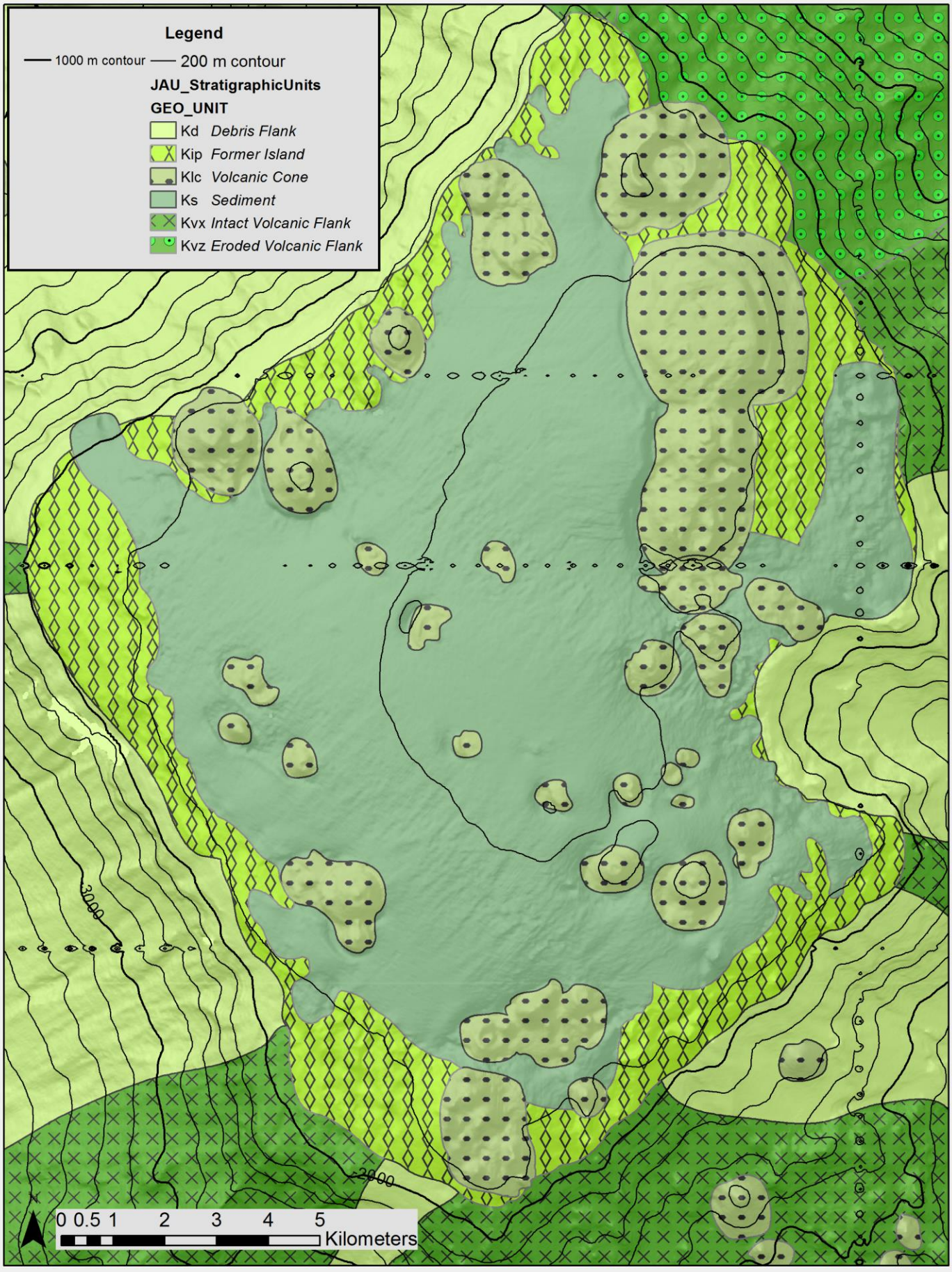

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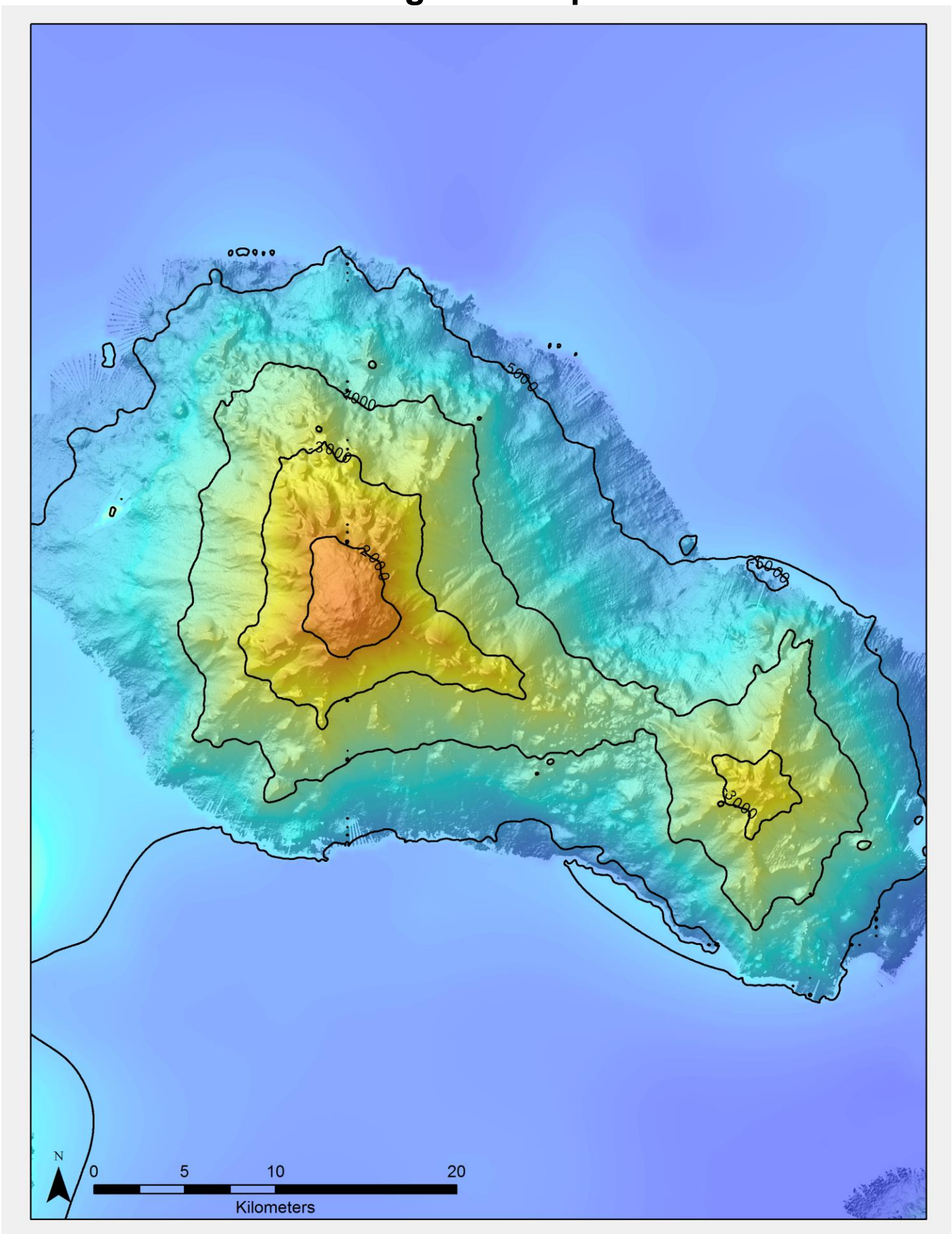

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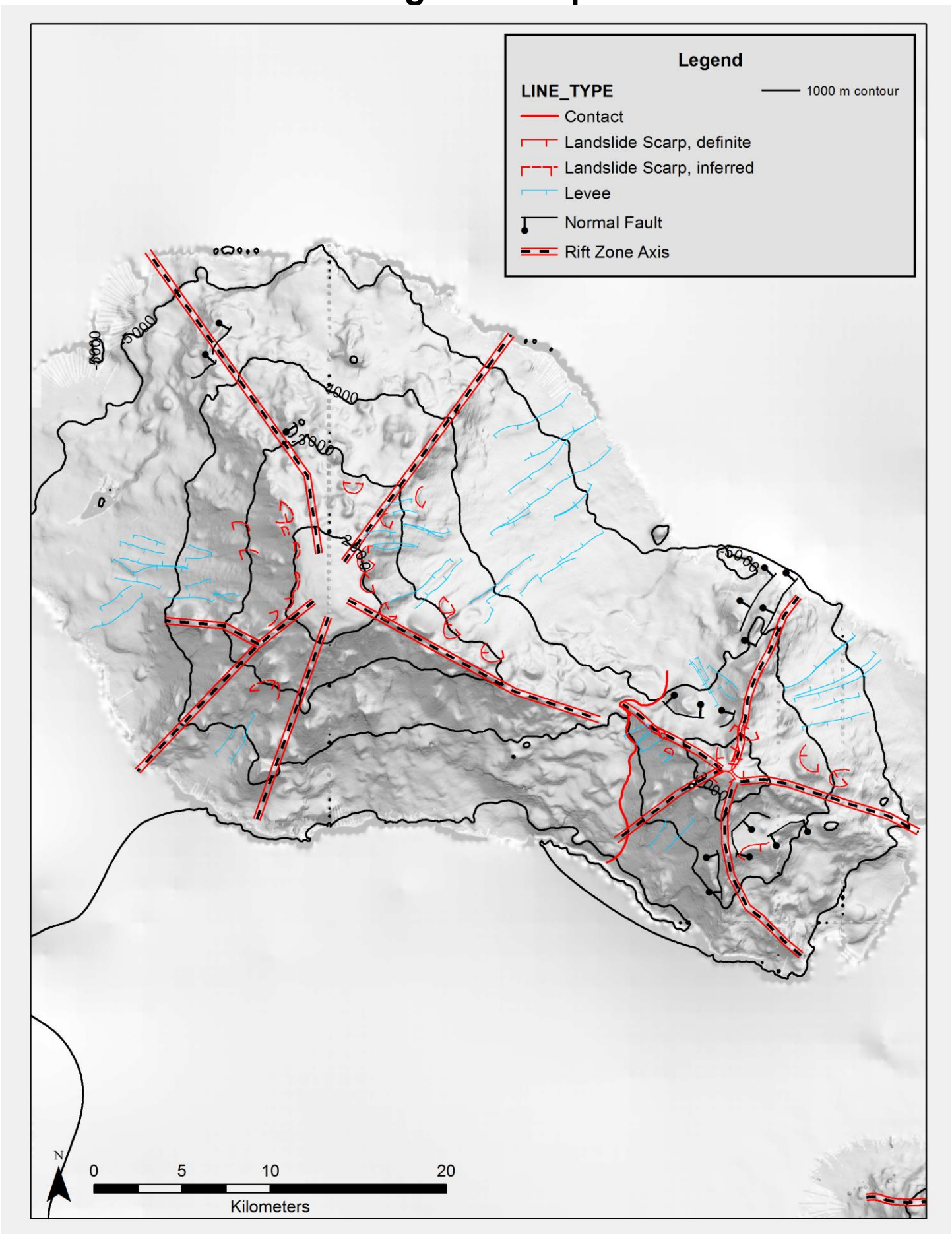

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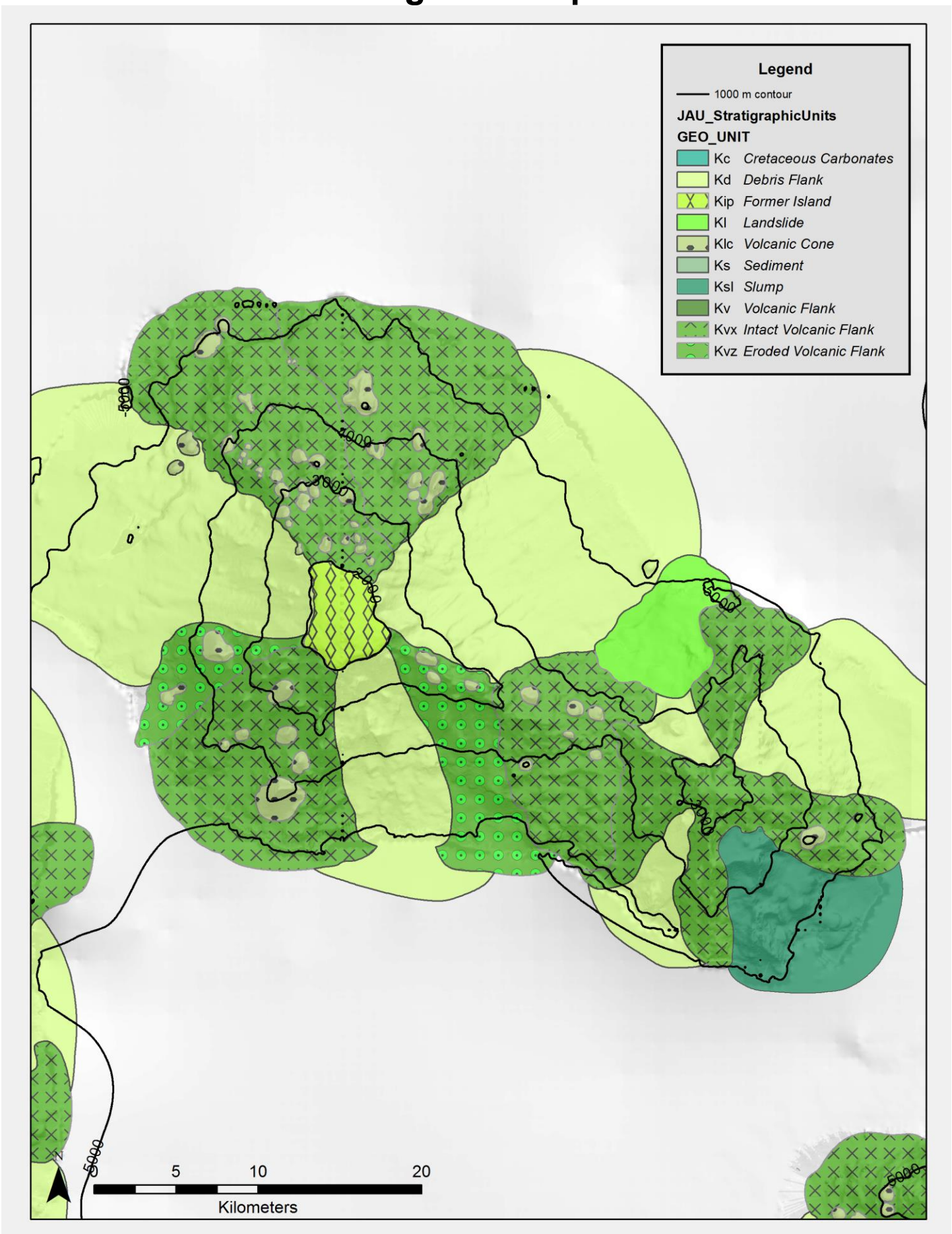

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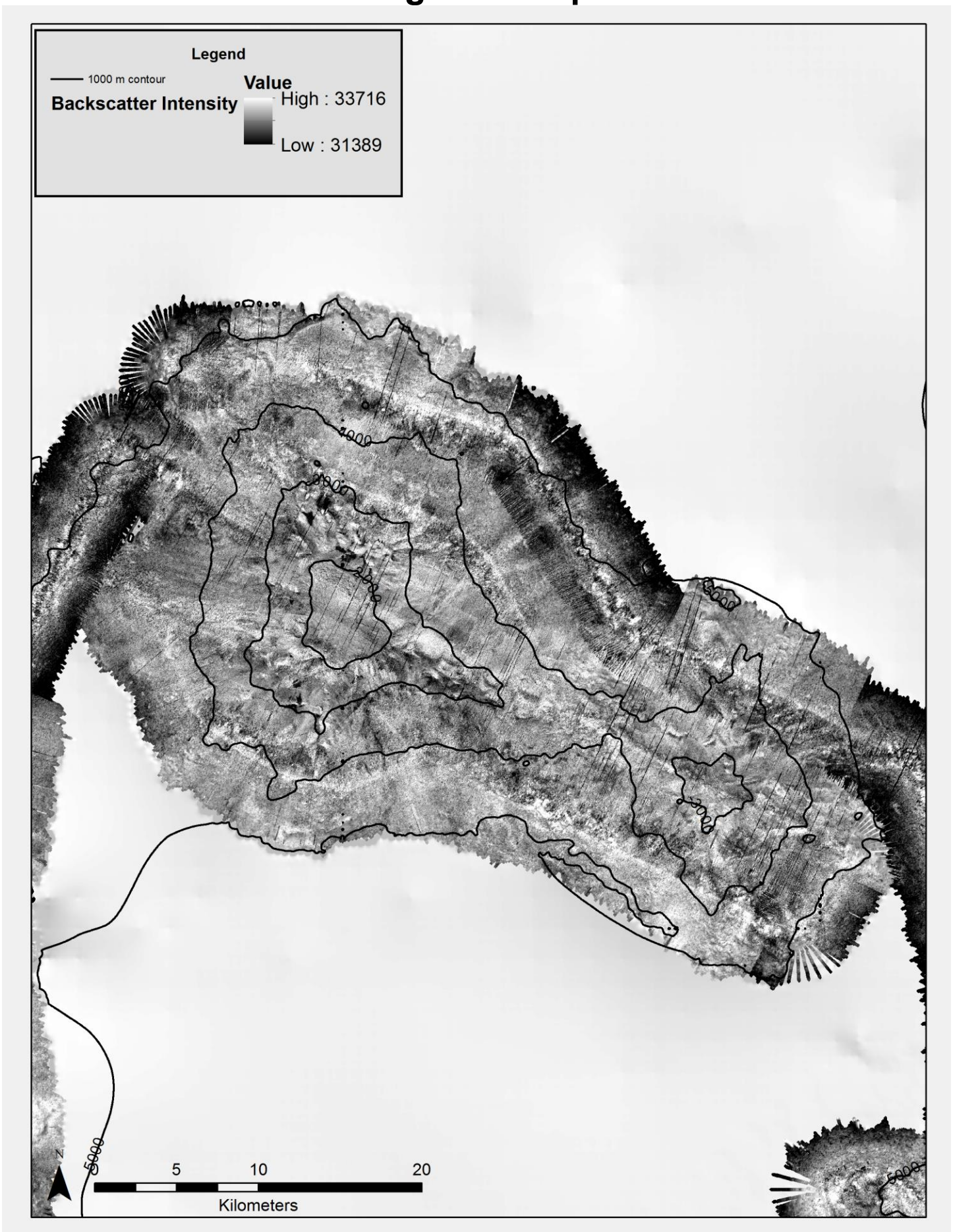

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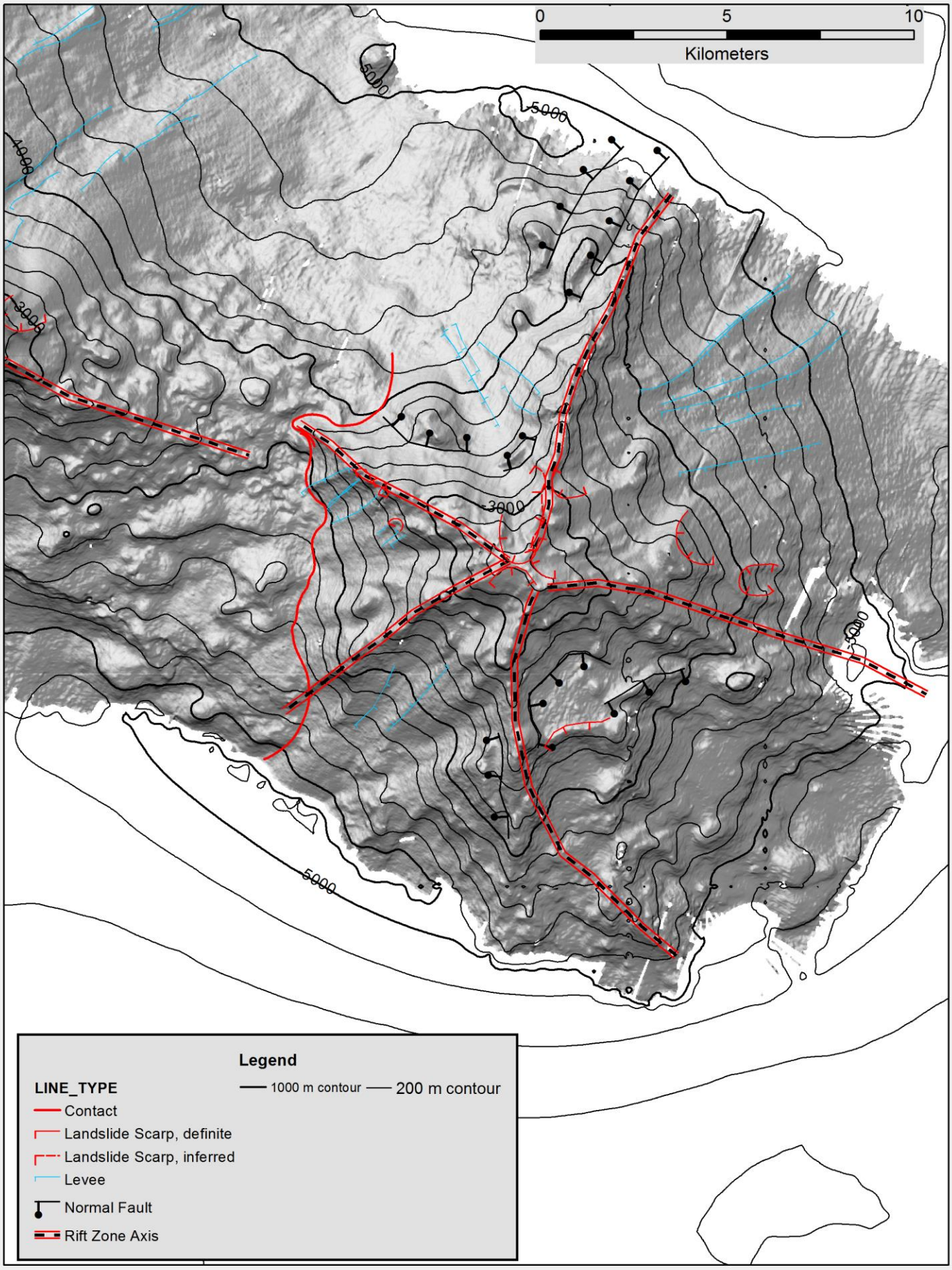

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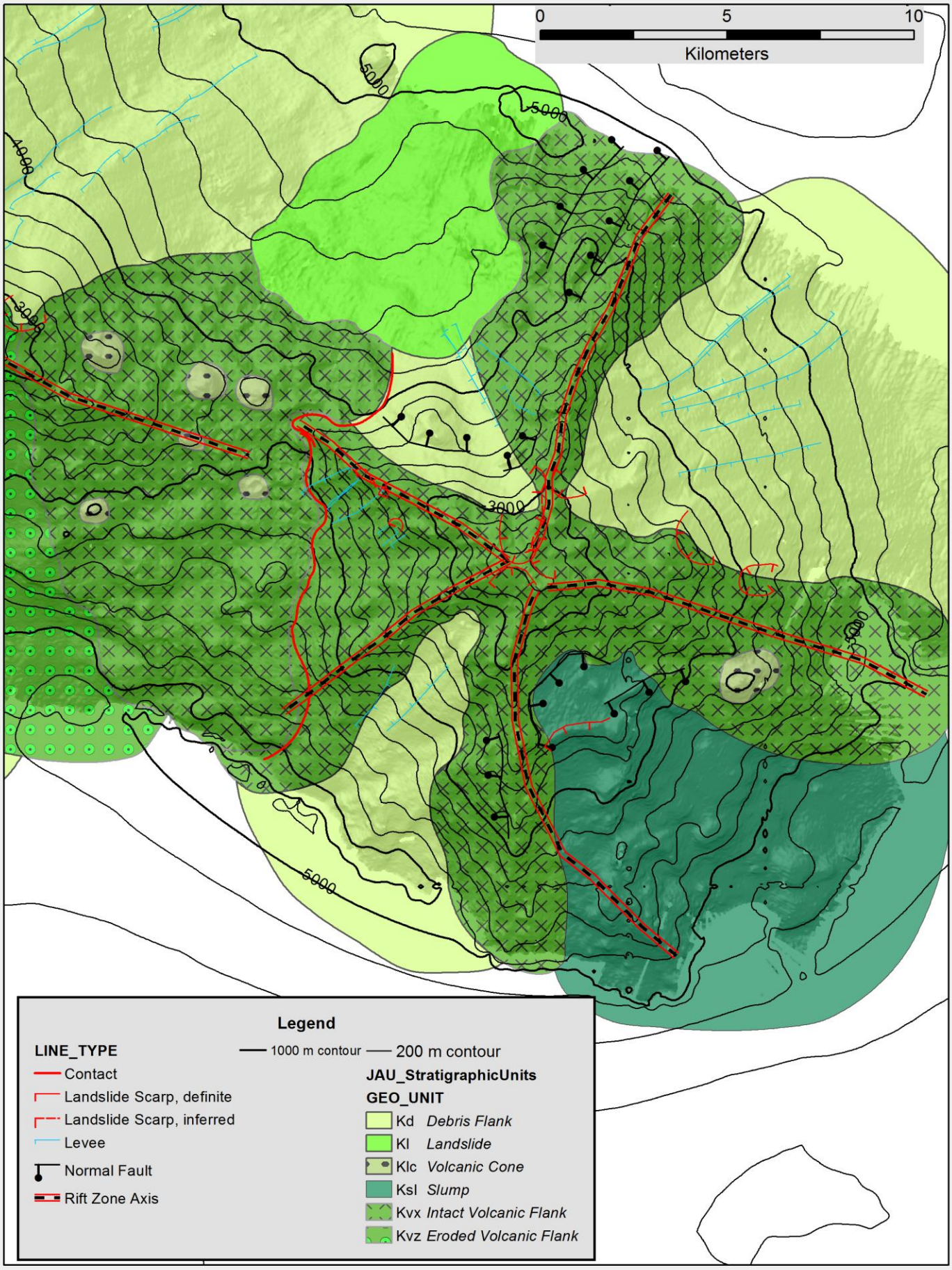

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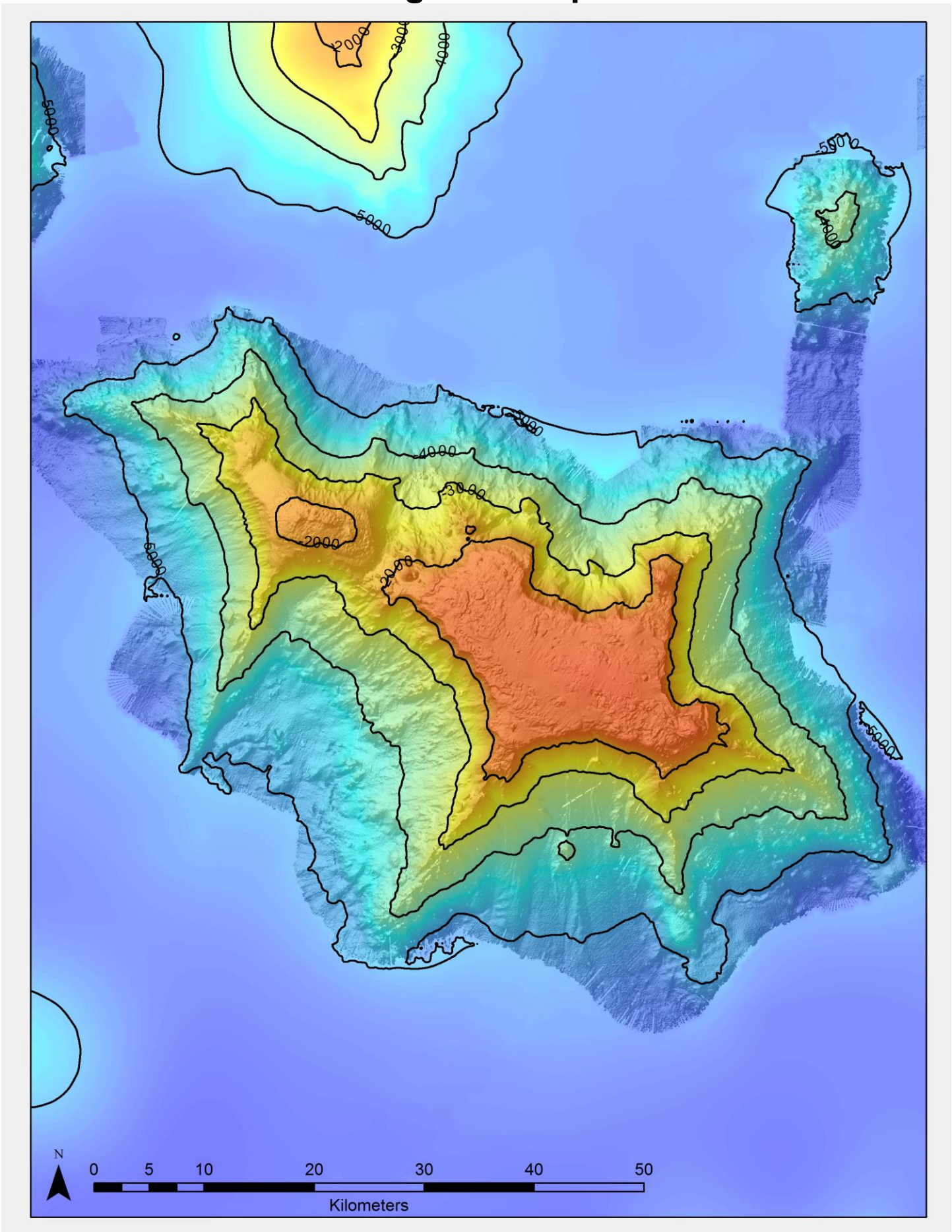

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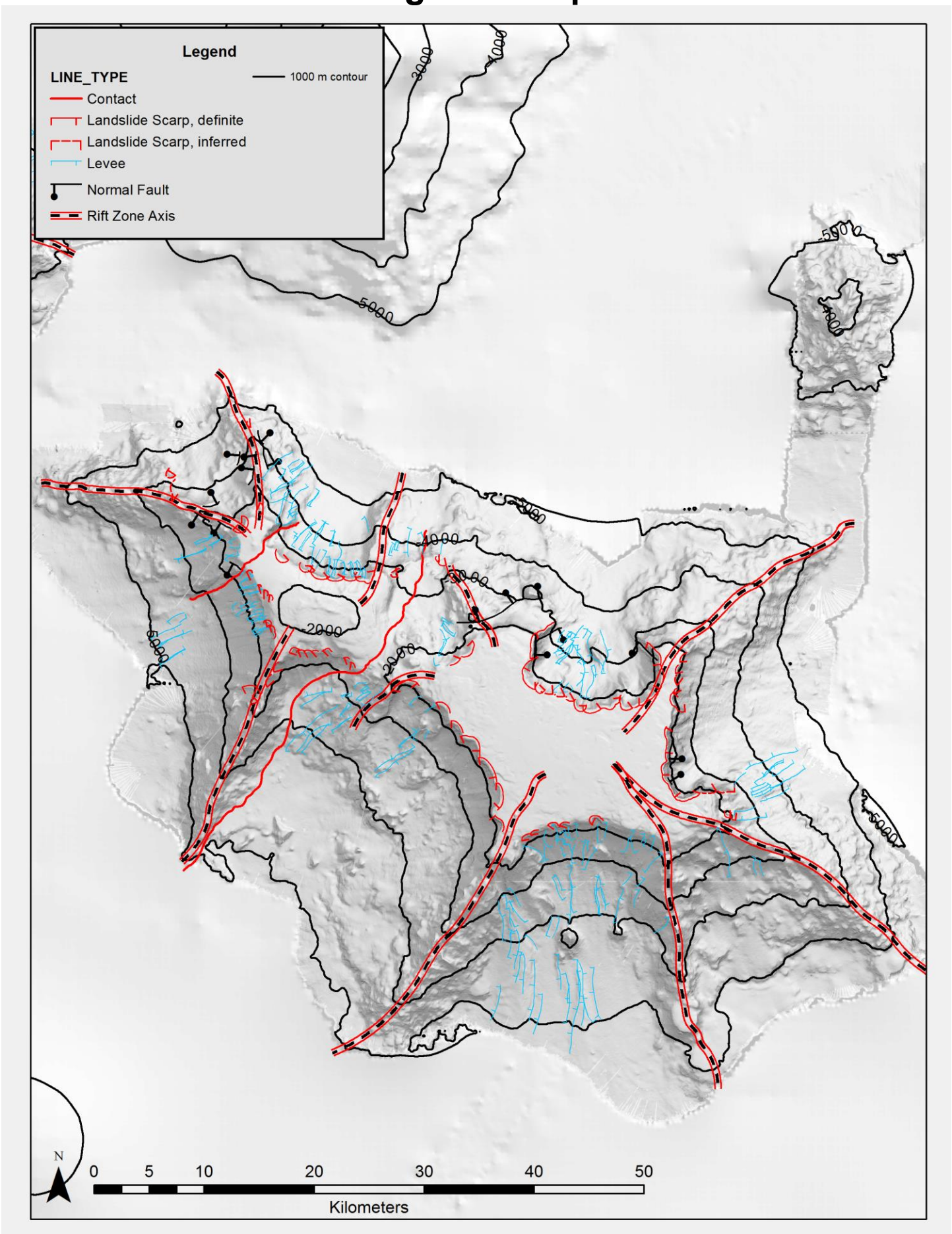

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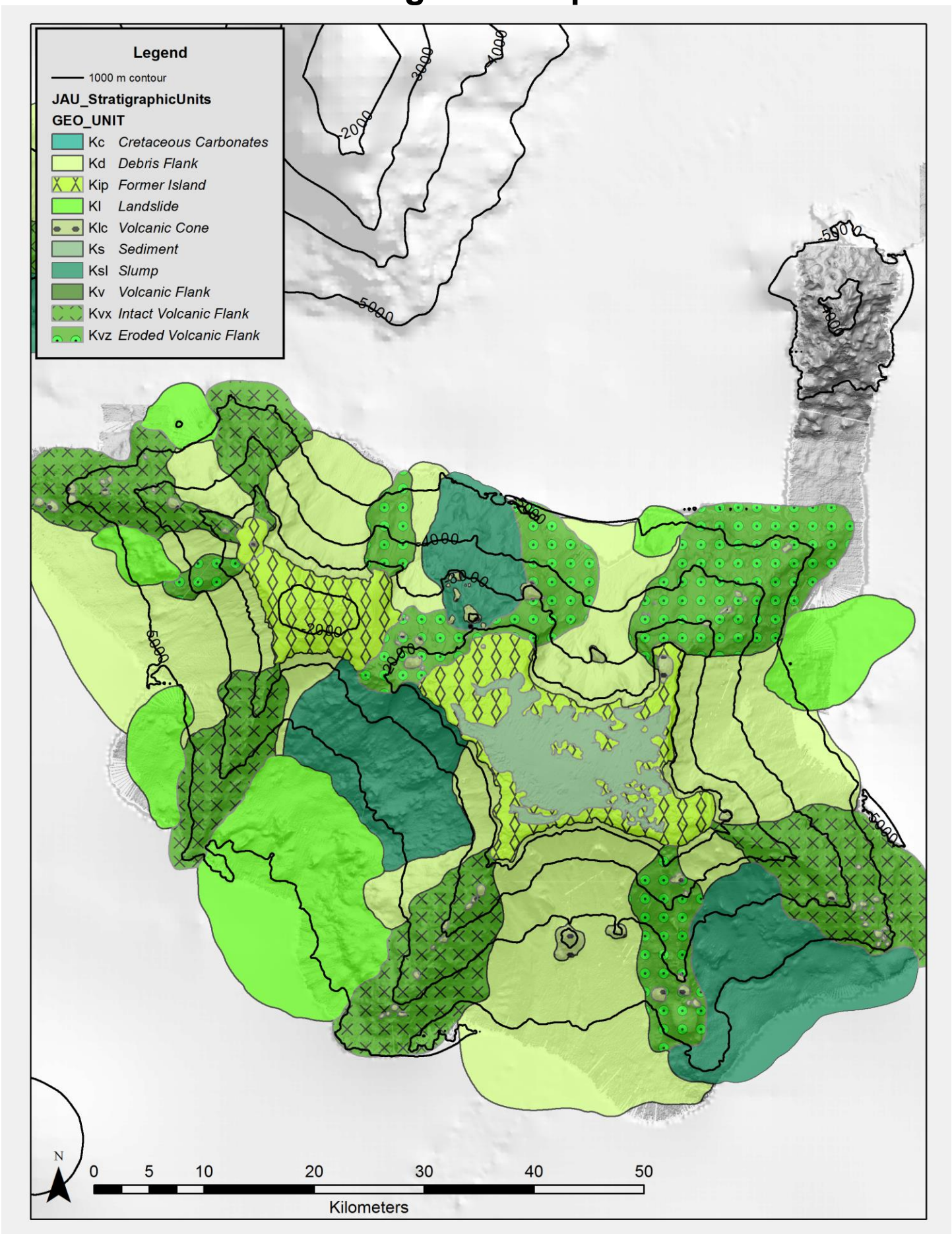

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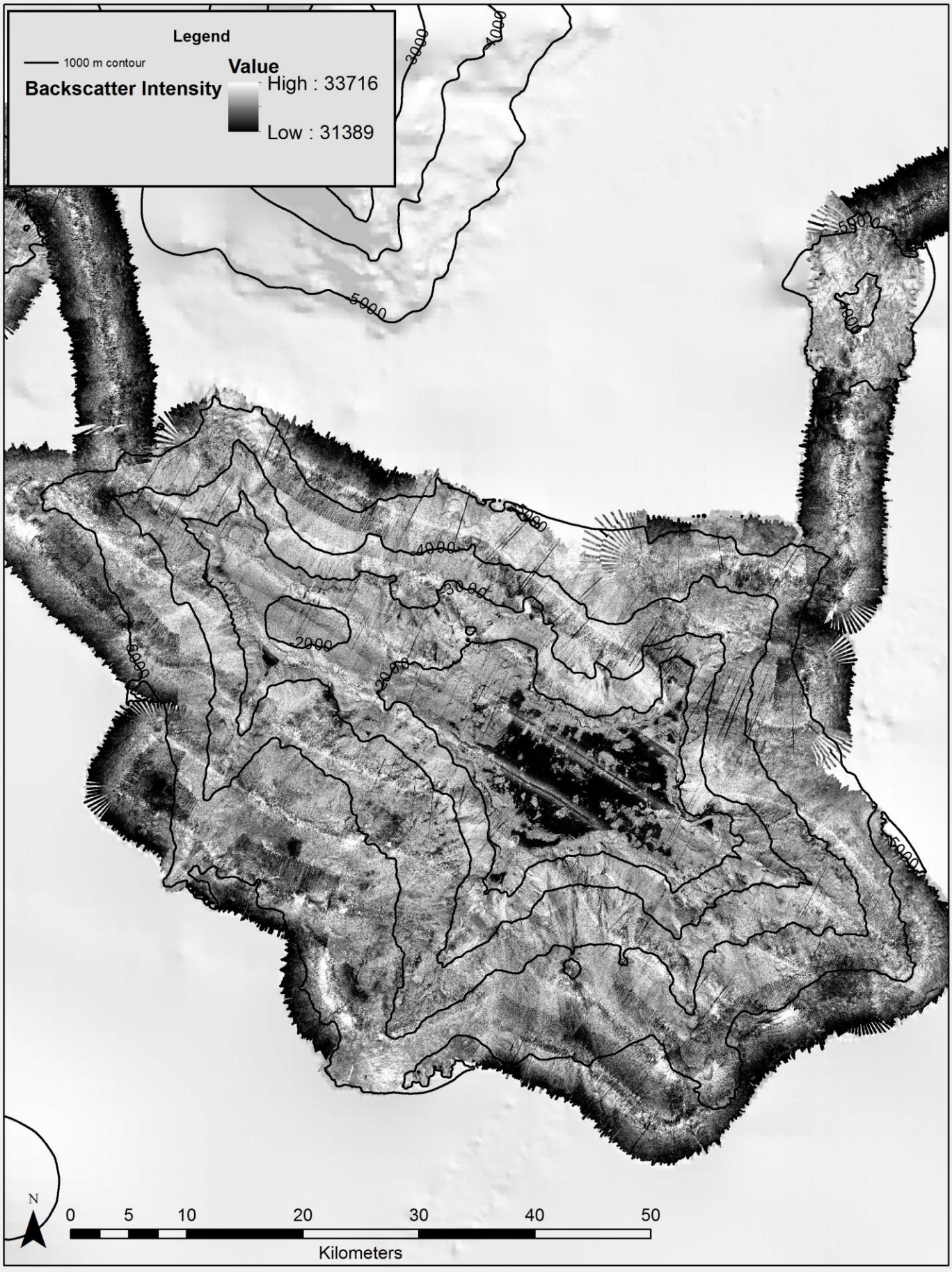

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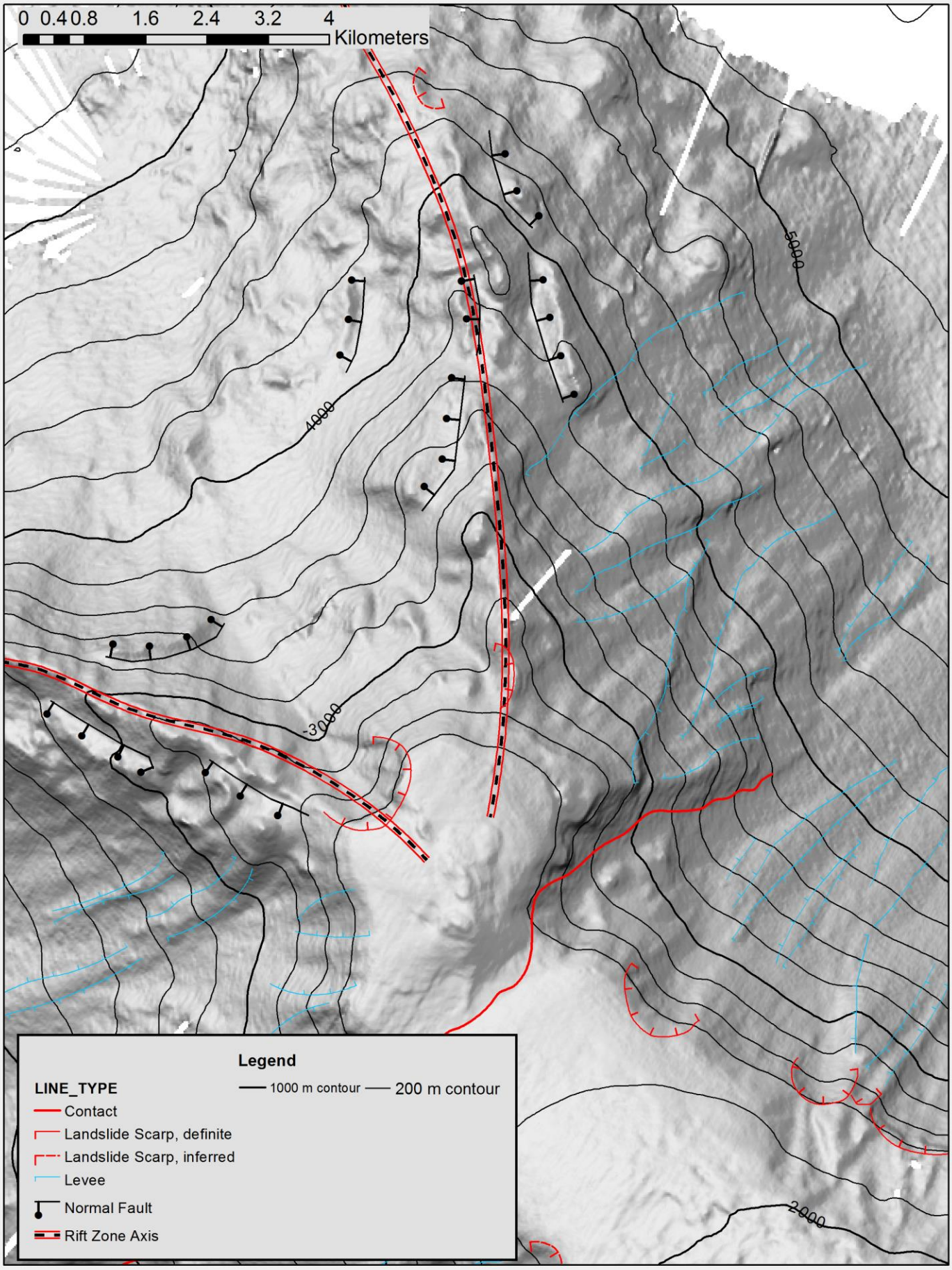

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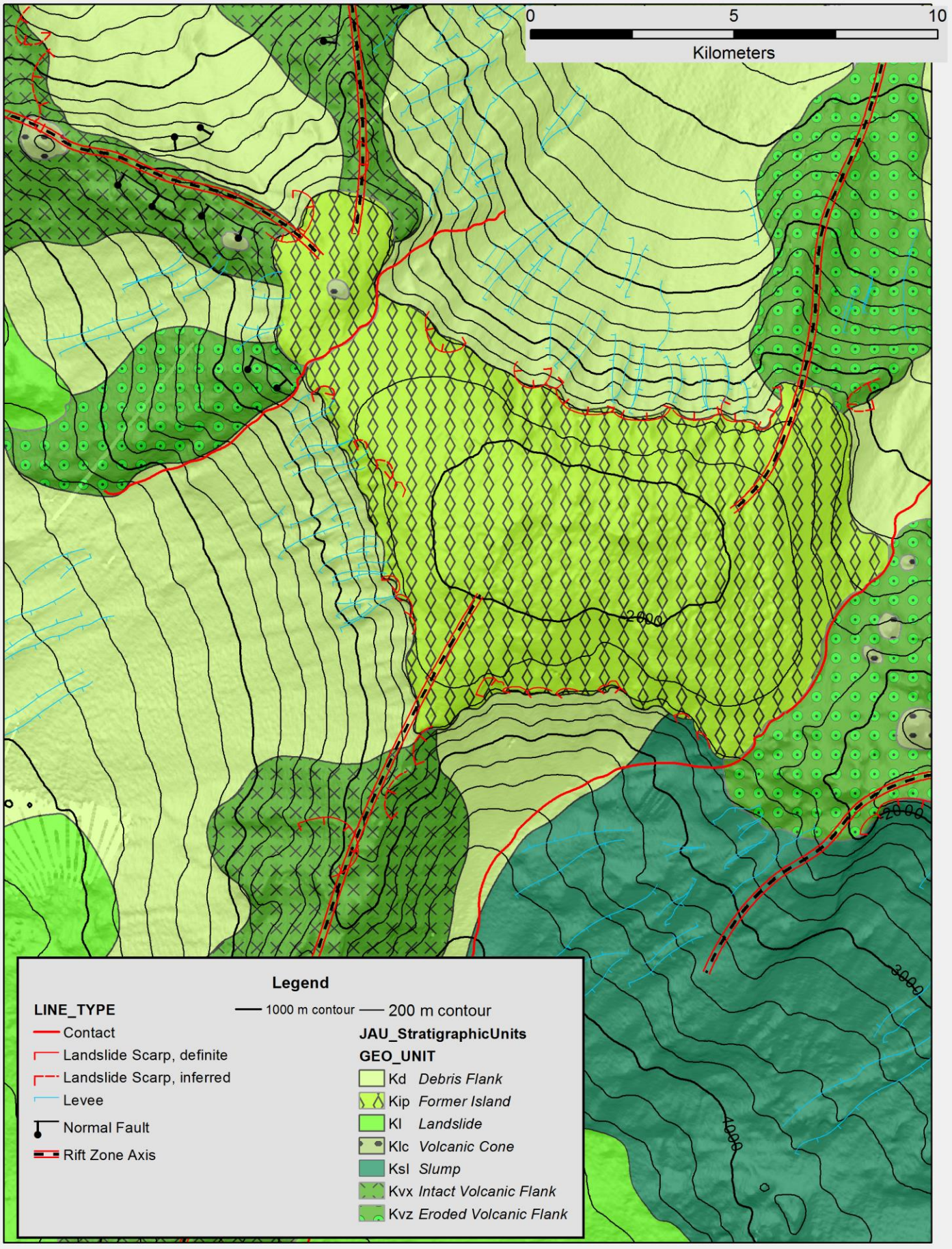

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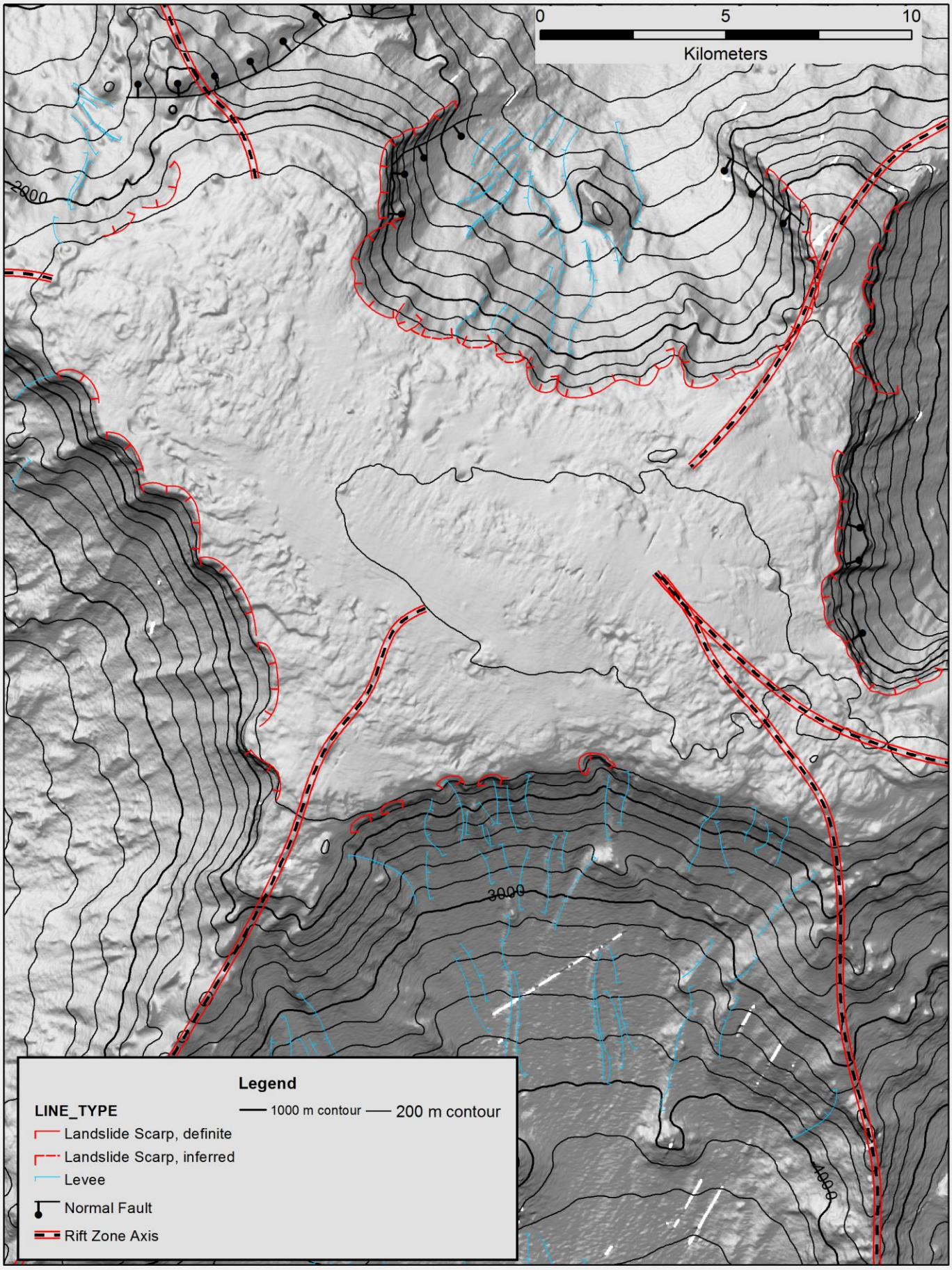

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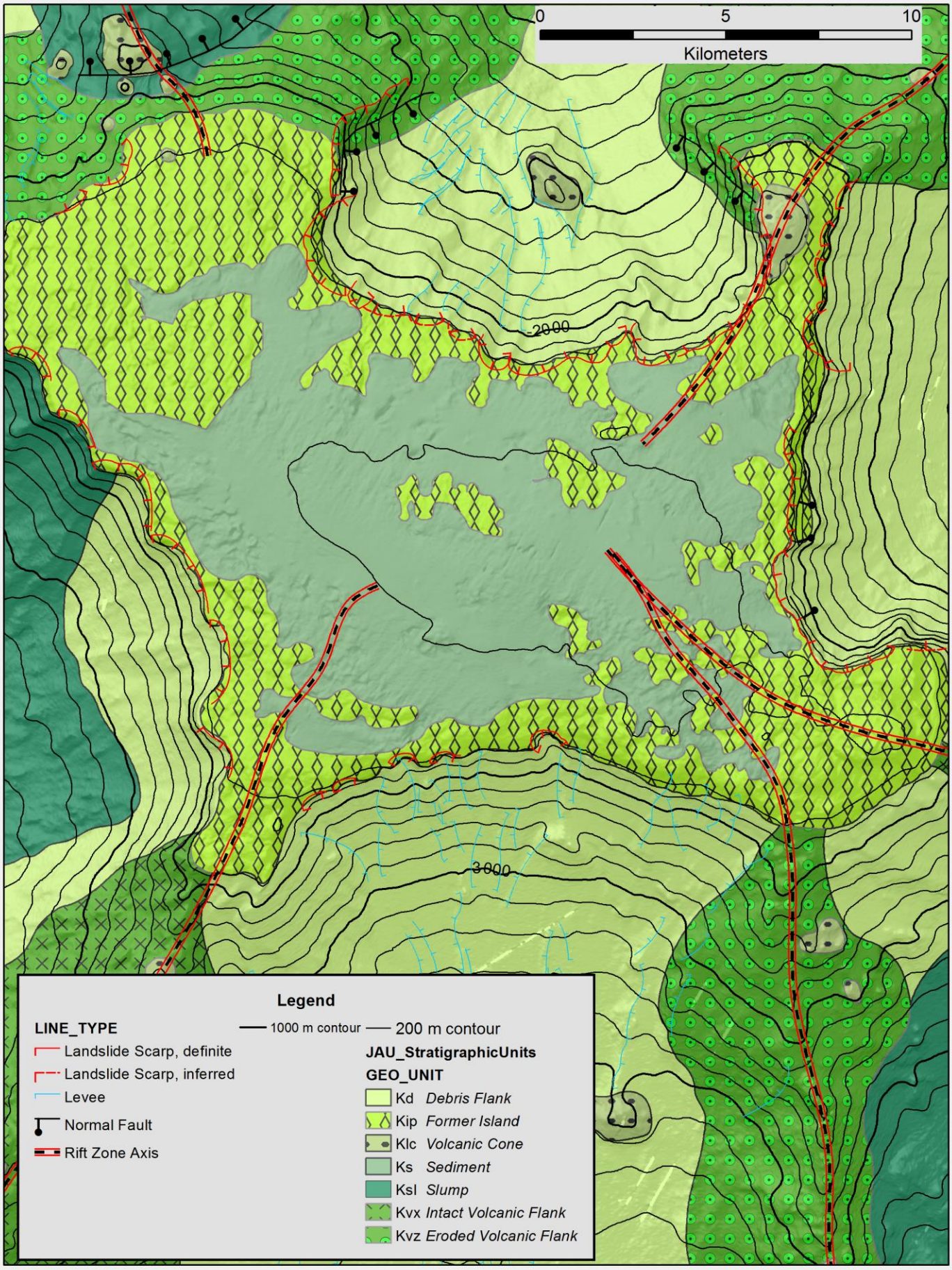

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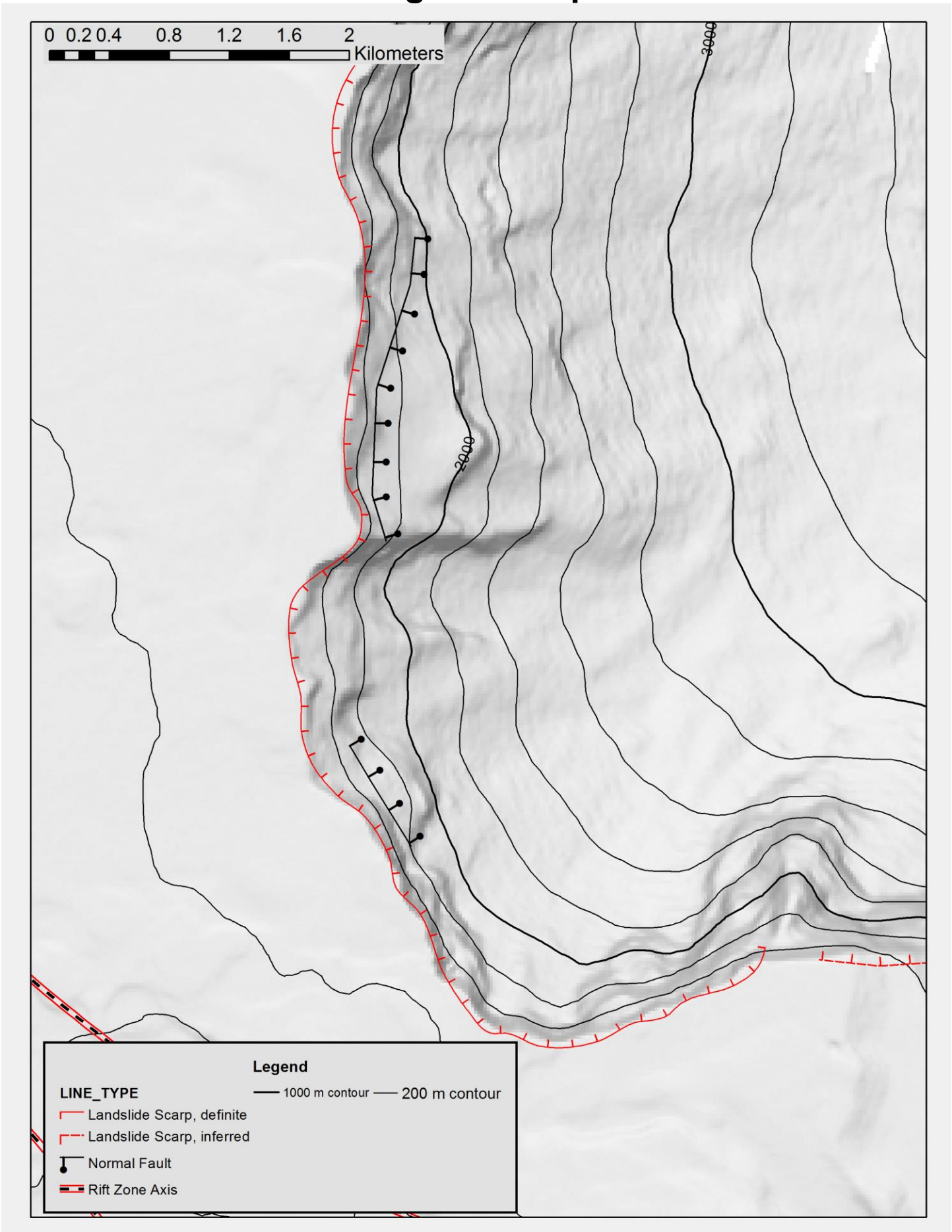

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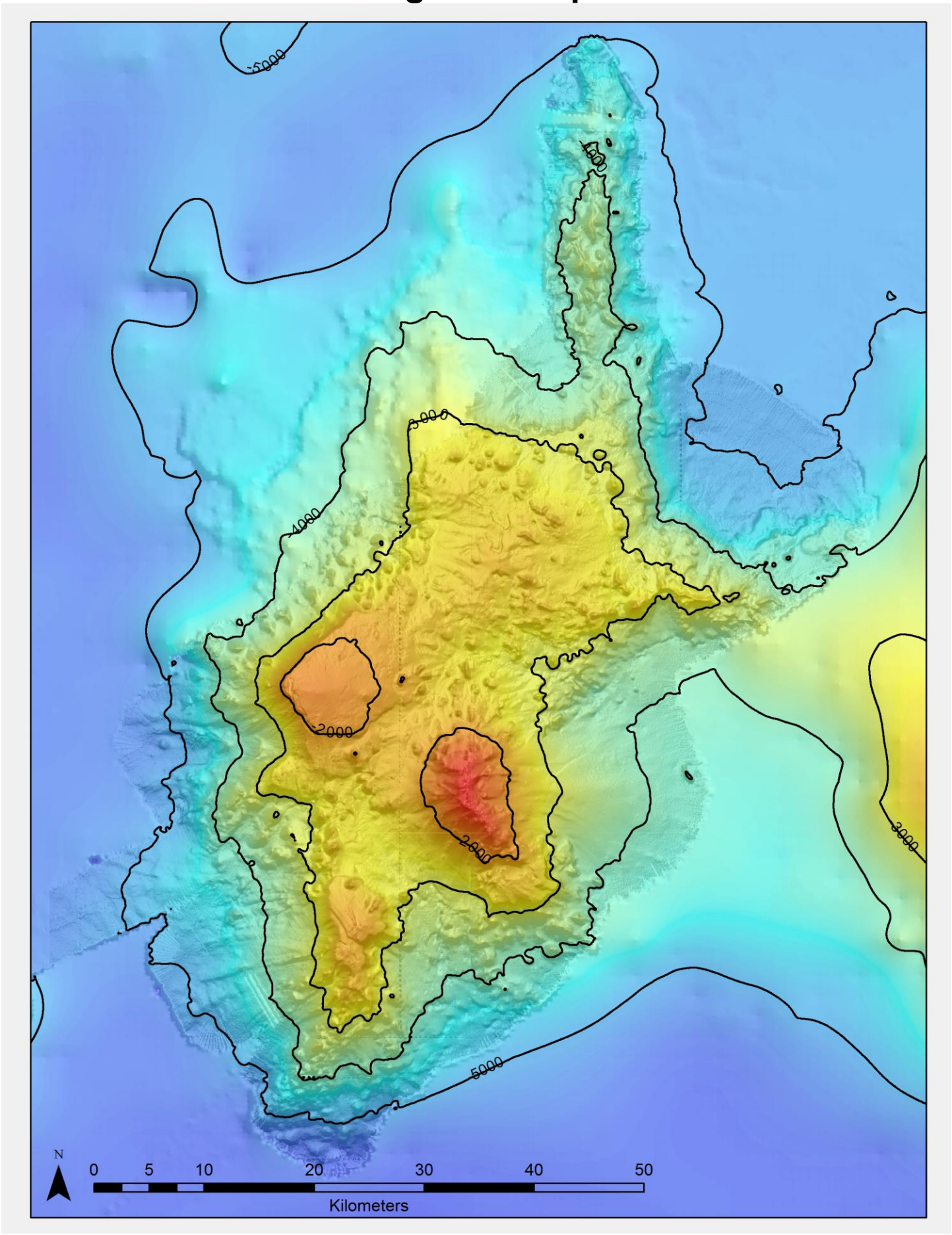

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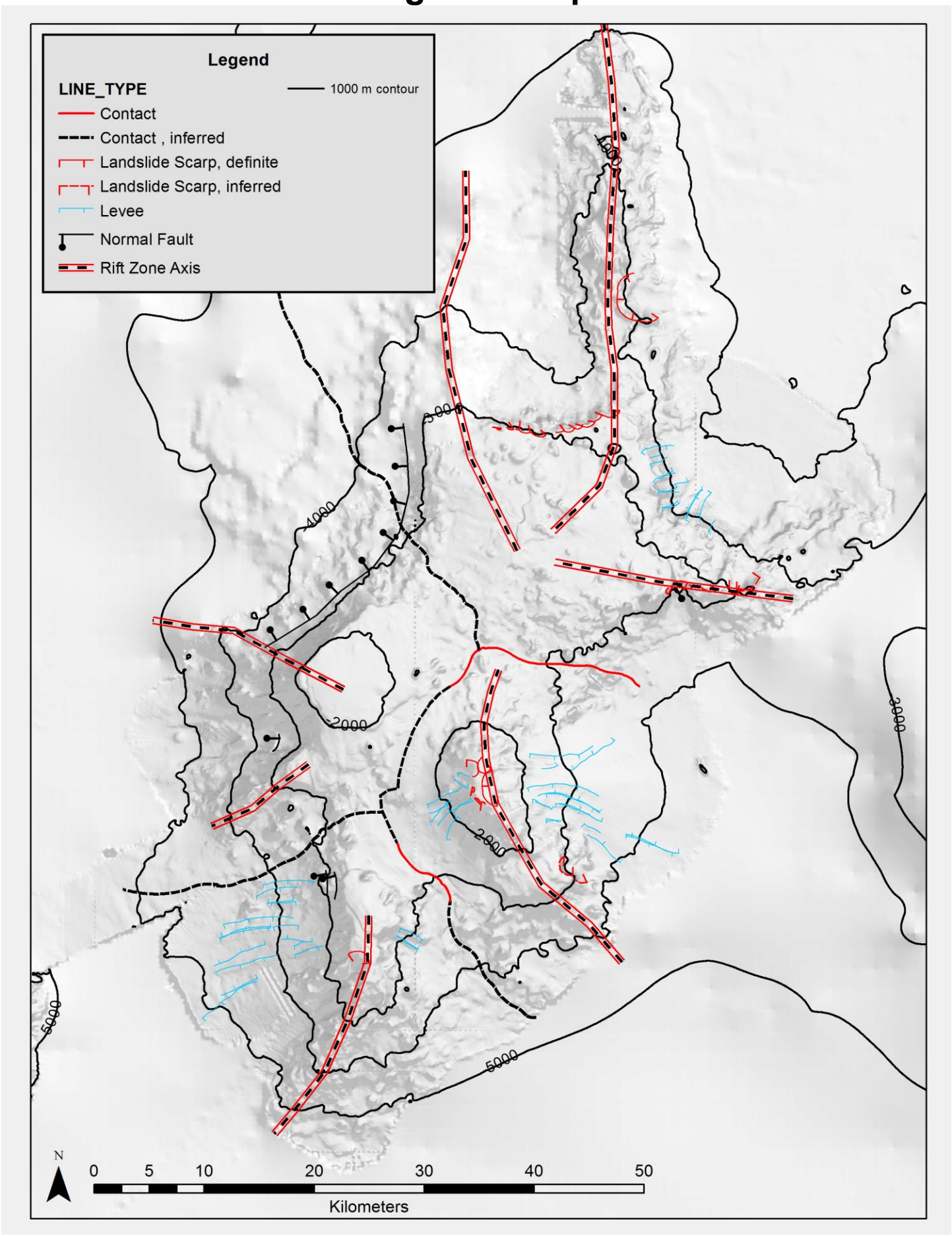

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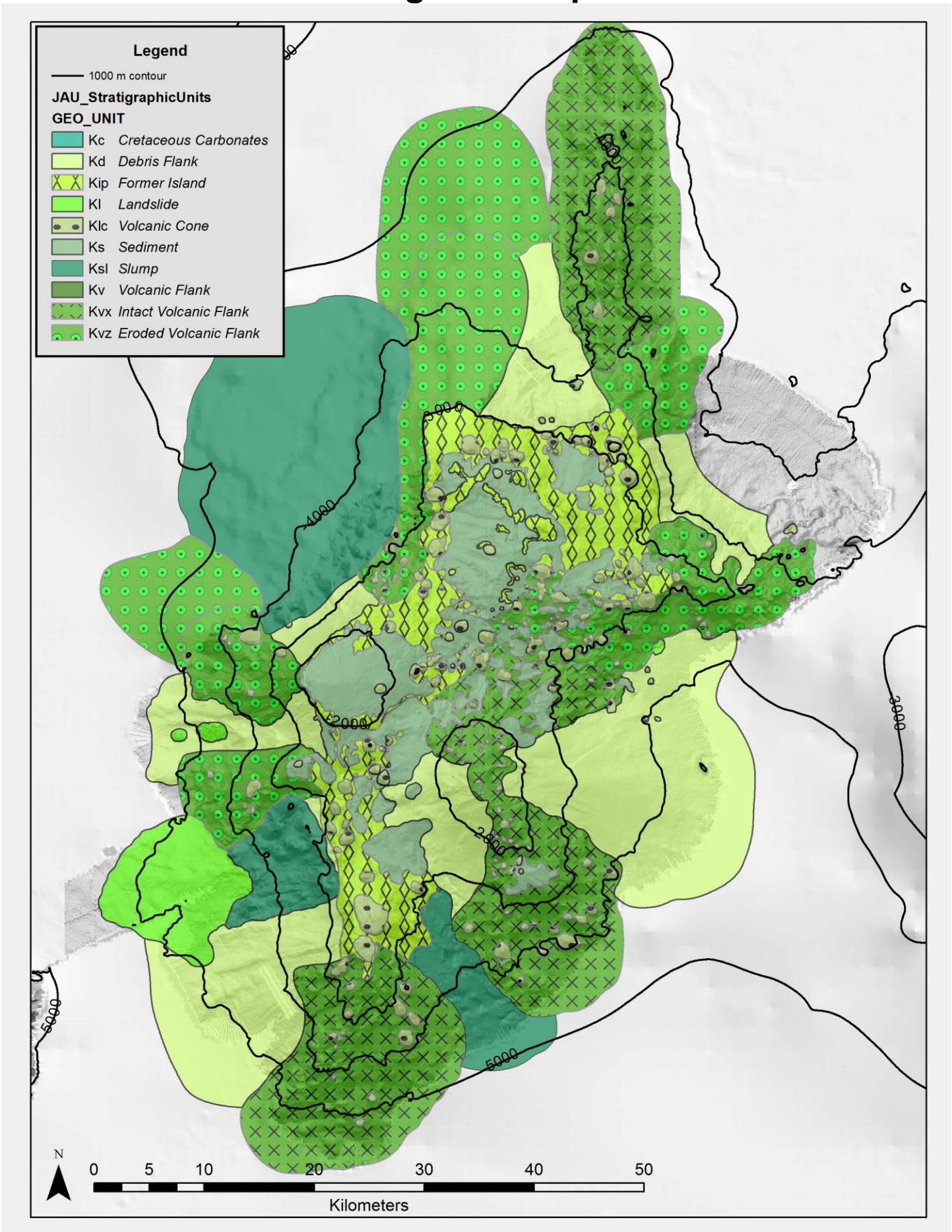

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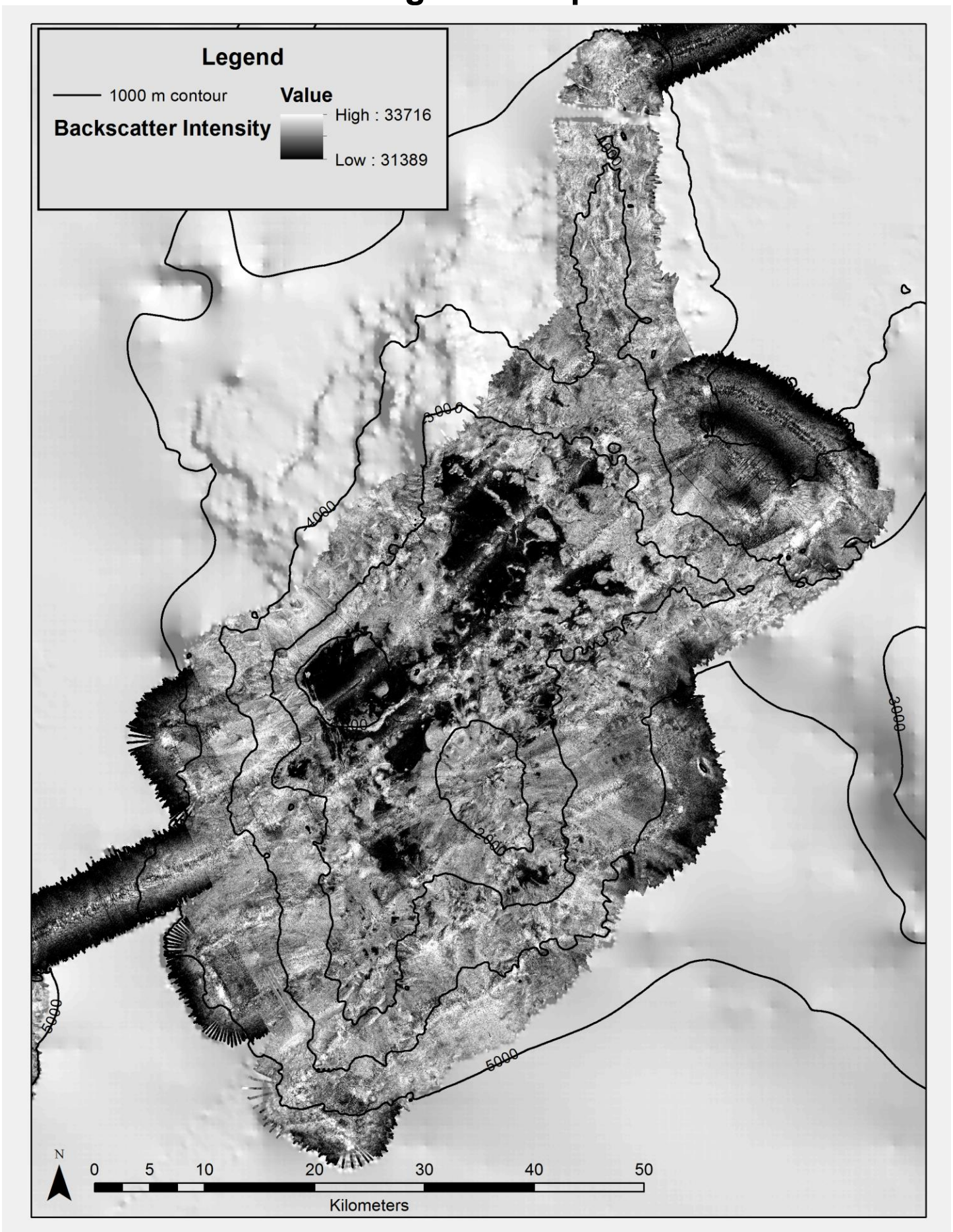

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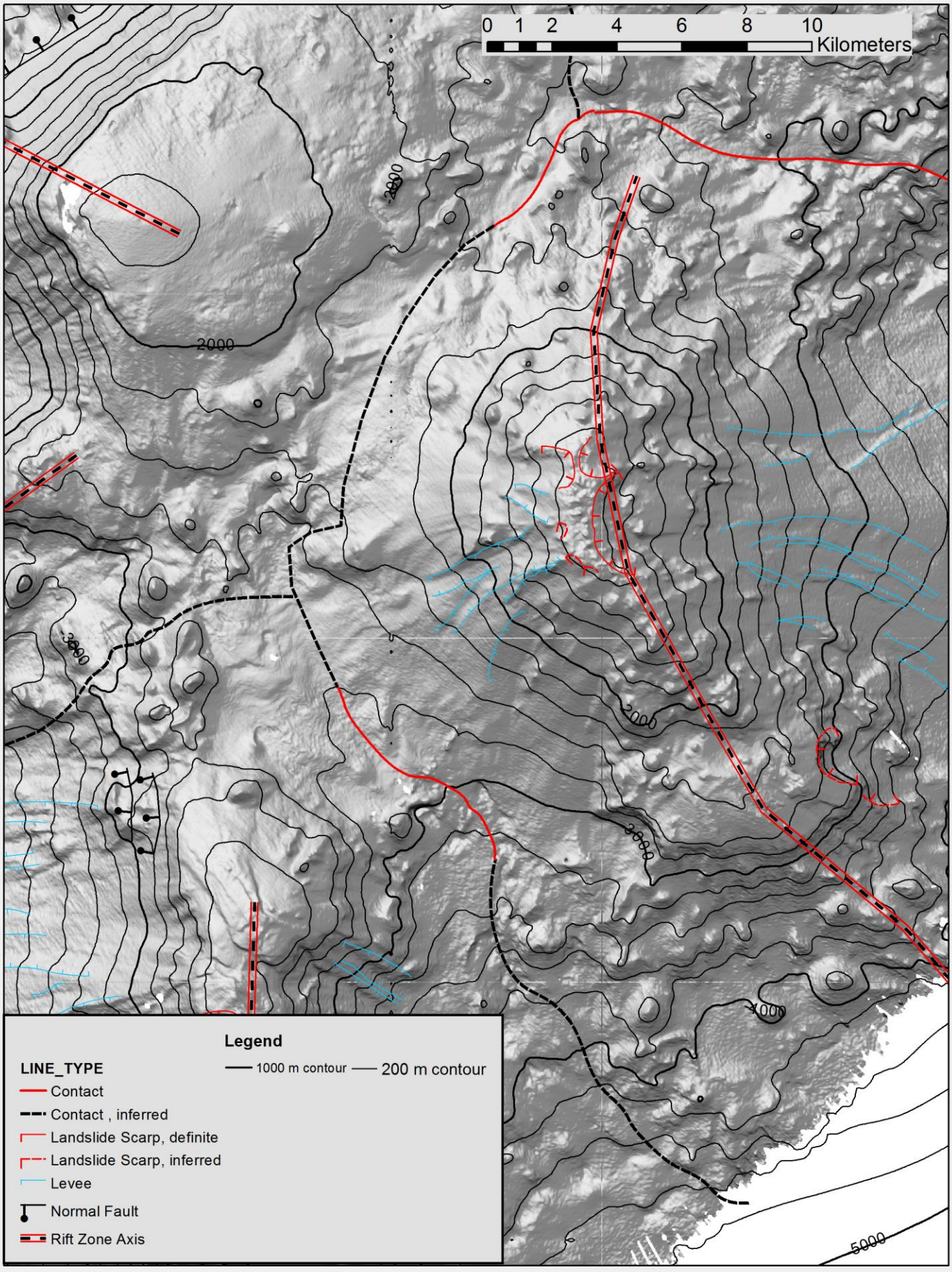

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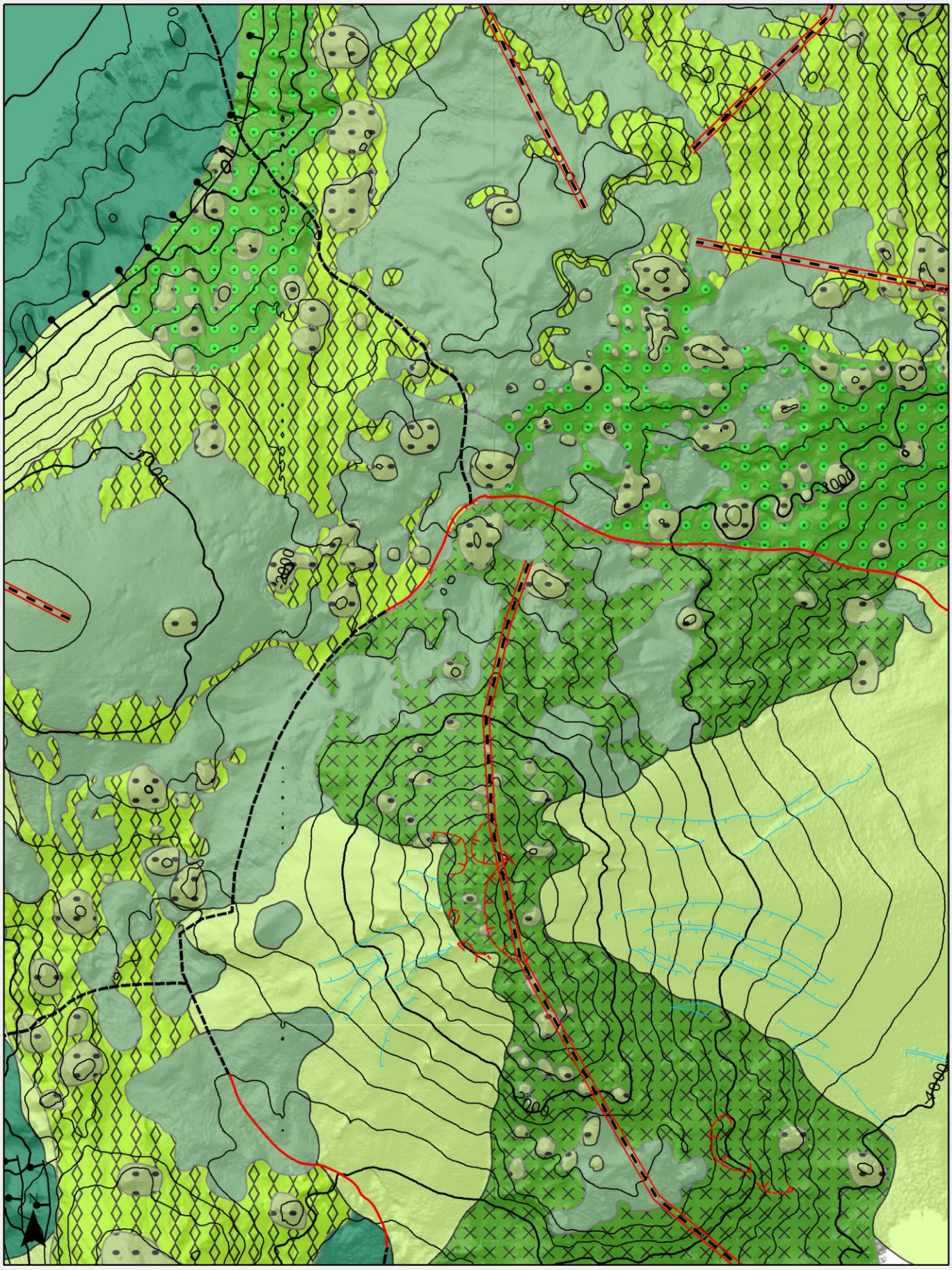

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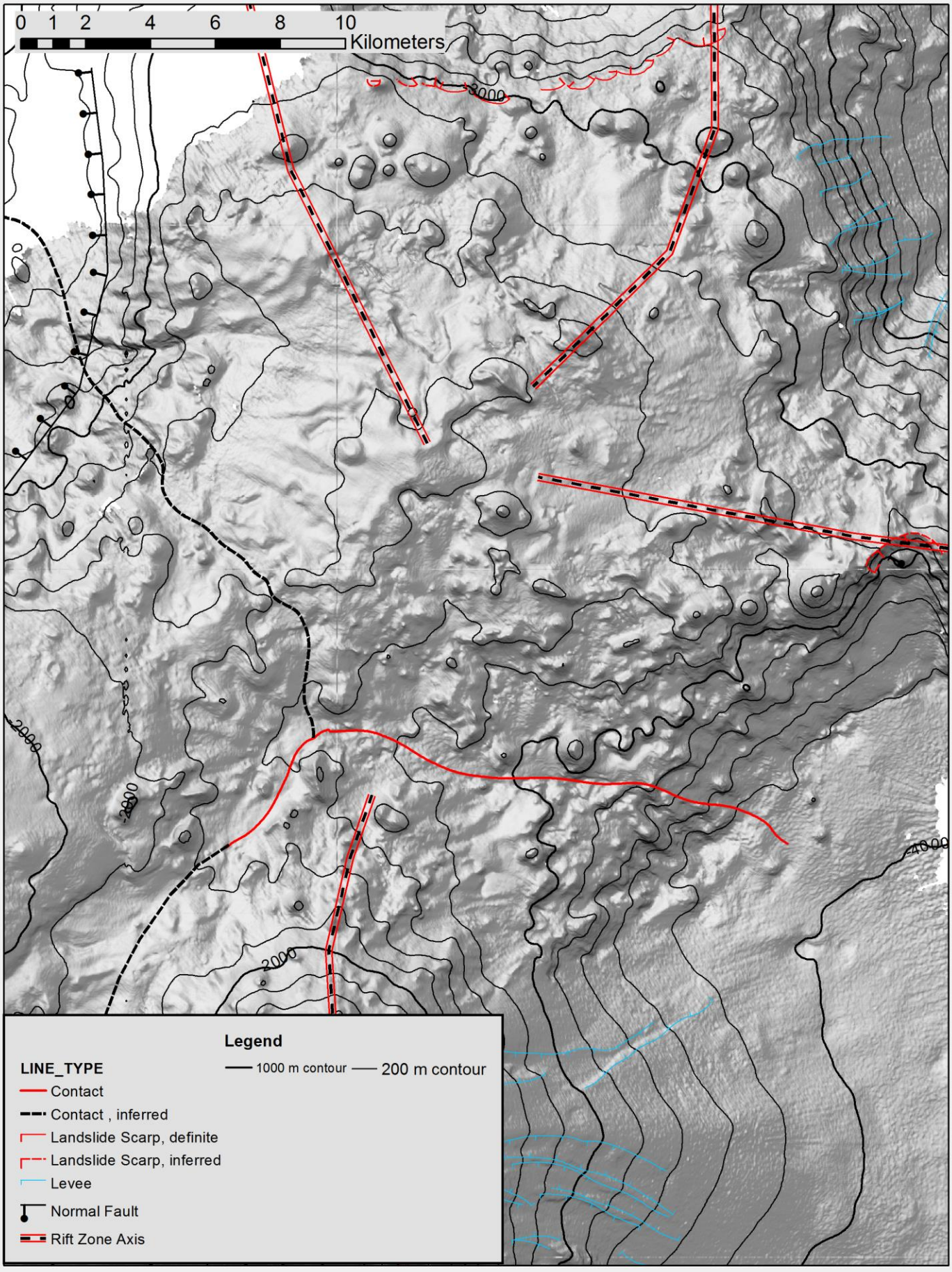

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