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Application of various fuzzy inference networks to integrate mineral exploration datasets: Implication for gold prospectivity mapping in Sonakhan greenstone belt, India

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Fuzzy modelling of multisource geoscience data and its implications to mineral prospectivity mapping is drawing wide attention of the mineral exploration sector. Mineral deposits are basically end products resulted from optimal combination of certain metallogenetically favourable earth processes which leave their imprints in the associated geological entities at a range of scales that can be interpreted from their direct or indirect manifestation in several geospatial datasets. Therefore, in geologically potential yet under-explored or greenfield areas with no or very few discovered mineral deposits, the qualitative knowledge on the spatial relationship between mineralisation of interest and geoscience data could be an important guide to delineate exploration targets. In such a case, fuzzy set theory aided with Geographic Information System (GIS) is preferred as an effective mechanism for the transformation of subjective knowledge into quantitative information that further helps in modelling of earth science data.

The Archaean to Paleo-proterozoic Sonakhan Greenstone Belt (SGB) located in the north-eastern fringe of the Baster Craton in central India is considered as a potential geological terrane for mesothermal gold mineralisation based on its geological and geochemical similarities with other mineralised greenstone belts. In this case study, a part of SGB has been taken as a target area that exposes sequence of metamorphosed mafic to ultramafics rocks and associated metasedimentary units in a gneissic country and younger granites. Since the study area represents a less explored terrane in terms of mineralisation, the objective of this research is to generate gold prospectivity maps using fuzzy logic modelling. A total of 17 multiclass evidential maps were generated using four independent geoscience datasets viz. geological, geochemical, geophysical, and remote sensing. The sources of data include existing databases from the Geological Survey of India (GSI) and published work along with the newly produced exploratory data in this research. Fuzzy membership values (0-1) were assigned to each class of evidential maps based on subjective judgement. The fuzzyfied evidential maps were then combined using fuzzy operators (AND, OR, SUM, PRODUCT, and GAMMA) through a series of logical steps i.e. the fuzzy inference network. Two different fuzzy inference networks were created using several combinations of fuzzy operations and accordingly, two prospectivity maps resulted which were classified as very high, high, moderate, low, very low favourable zones. To further enhance the result, the two maps were intersected to produce the final gold prospectivity map in support of targeting gold exploration in

the region. A part of the study area, that is the Baghmara gold block, that was already identified as a gold enriched block based on traditional exploration works, coincides with the very high to high favourable zones predicted in the final map and this ensures the reliability of the gold prospectivity map and the efficiency of the adopted fuzzy logic approach in delineating promising targets for exploration.