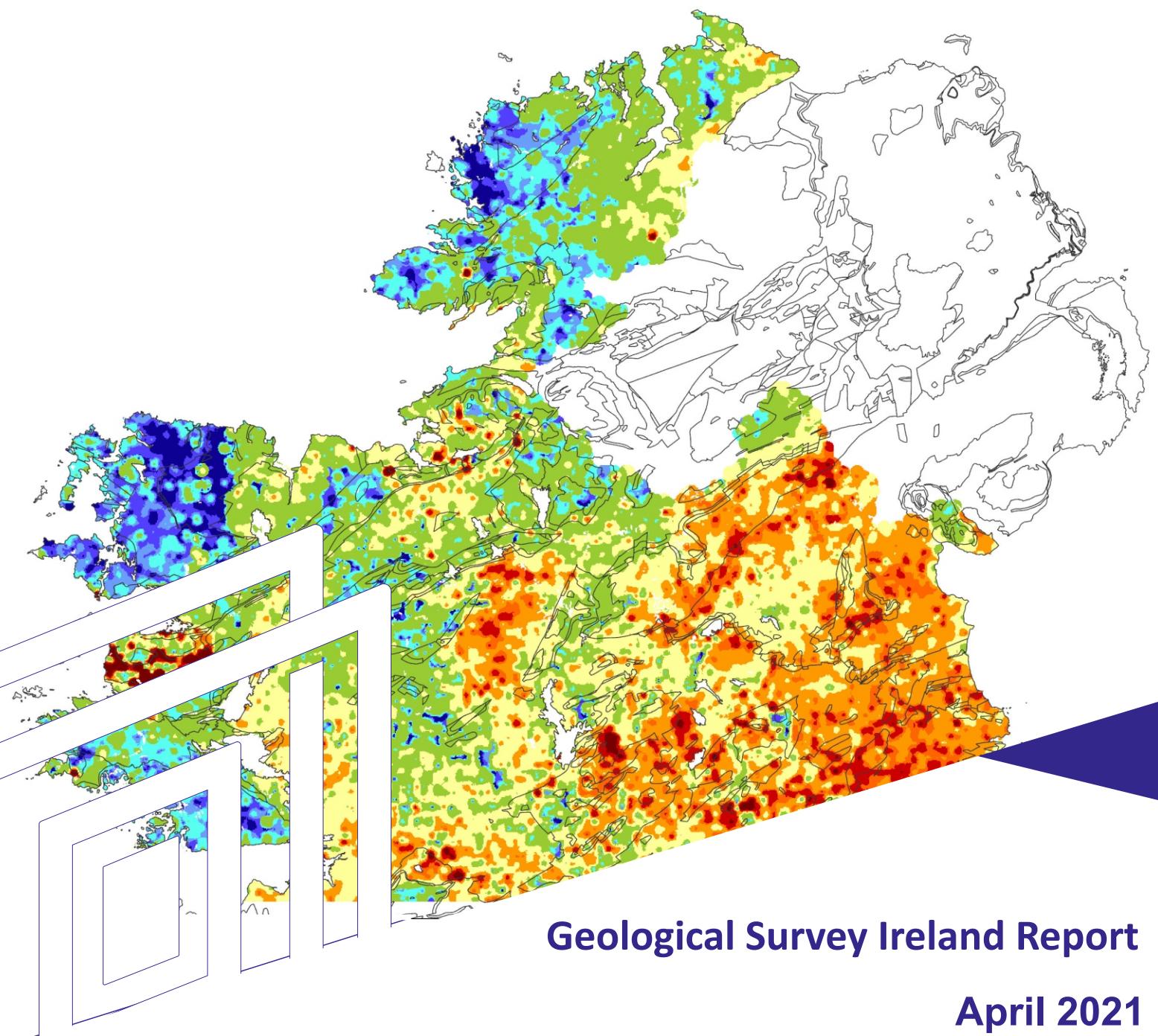




Tellus Geochemical Survey: deeper topsoil multi-element maps for the northern half of Ireland



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Executive summary

This publication presents interpolated maps of geochemical data for deeper topsoil samples across the northern half of Ireland. Samples were collected between 2011 and 2019, as part of the Tellus geochemical survey project of Geological Survey Ireland (Figure 1).

The maps presented here represent almost 10,000 sites covering the north-midlands, northwest and border counties of Ireland, an area of just over 35,700 km², and they represent a wide variety of geological domains in Ireland (Figure 2).

Each sample was prepared and chemically measured by a number of techniques. Laboratory tests comprise: soil pH (CaCl₂); loss-on-ignition at 450°C and multi-element partial extract analyses of major, minor and trace elements by ICP following *aqua regia* digestion. ICP (*aqua regia*) analyses were conducted by ALS Minerals Ltd., Ireland.

Acknowledgements

Geological Survey Ireland and the Tellus geochemistry team gratefully acknowledge the efforts of all project partners, contractors and especially field samplers, and the kind co-operation of all landowners and stakeholders.

This publication is published with the approval of the Director, Geological Survey Ireland.

Disclaimer

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1. Introduction

1.1. Sample collection and analysis

Soil samples were collected from 9,921 sites in Ireland between 2011 and 2019 as part of Geological Survey Ireland's (GSI) Tellus programme (Figure 1). Regional samples were collected at a sampling density of one sample per 4 km², i.e. one sample per 2 x 2 km grid square. Periurban samples around Dublin and Galway were collected at a sampling density of one sample per 1 km², i.e. four samples per 2 km x 2 km grid square.

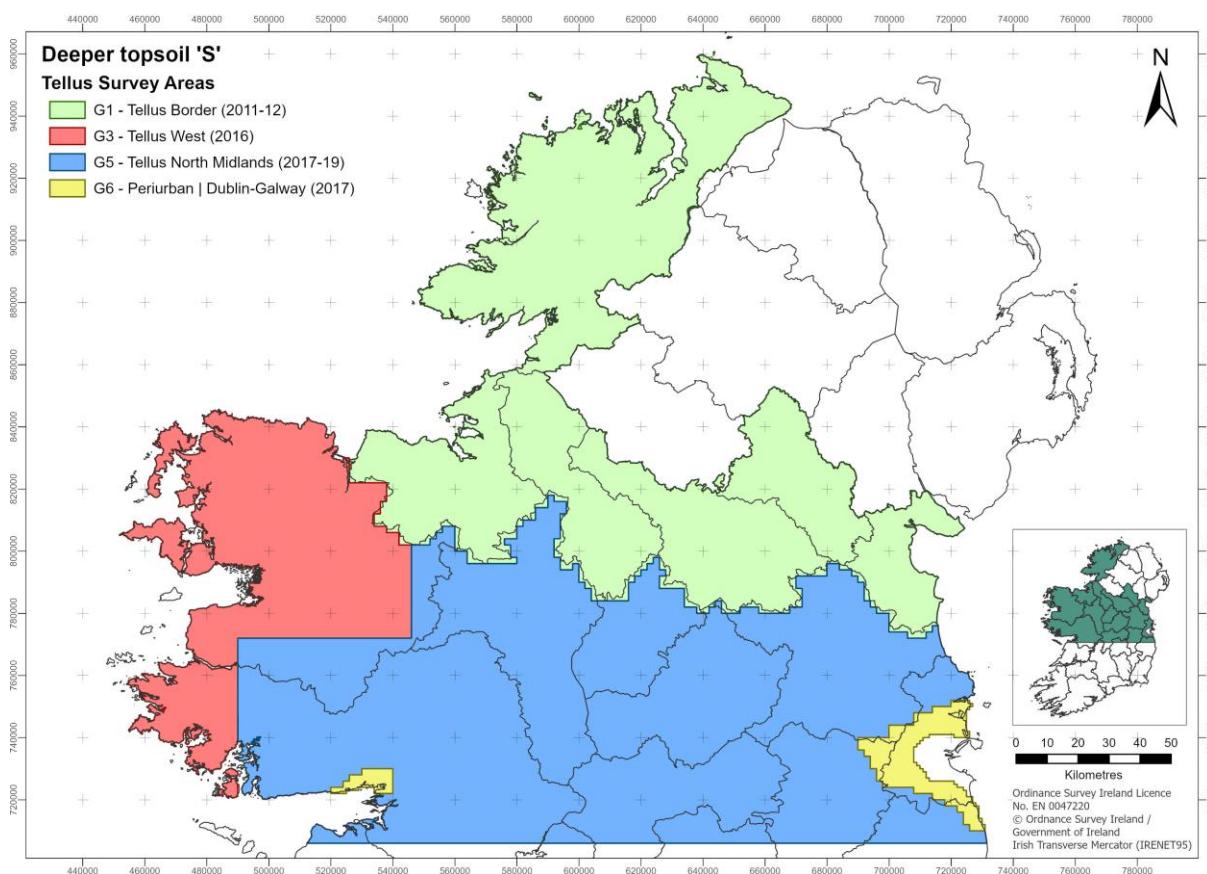


Figure 1: Deeper topsoil 'S' survey areas, completed by the Geological Survey Ireland's Tellus Programme (2011 and 2019).

Two soil samples were taken at each site using an auger, a shallow topsoil from a depth interval of 0.05-0.20 m (designated "A" soil) and a deeper topsoil from 0.35-0.50 m (designated "S"). Samples were analysed for pH, loss-on-ignition (LOI) and over 50 inorganic major and trace elements, using a variety of techniques. Sampling methodology, sample preparation, analysis and quality control measures are fully described in Knights *et al.* (2020) and Szpak *et al.* (2021). All data are freely



available from GSI (<https://www.gsi.ie/en-ie/programmes-and-projects/tellus/Pages/Data-and-Maps.aspx>).

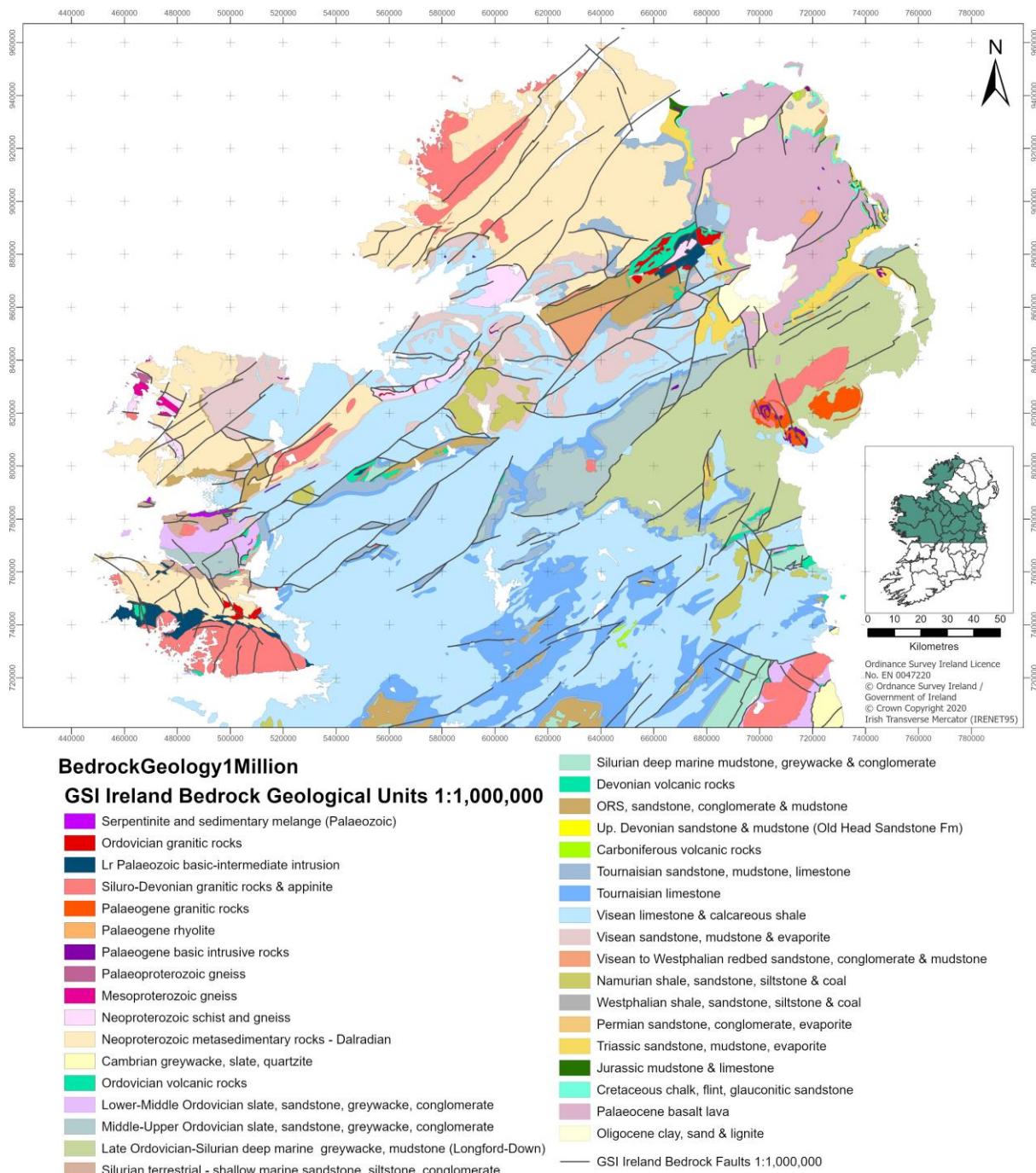


Figure 2: Bedrock Geology of Ireland (scale: 1:1,000,000).



1.2. Data processing and map production

The maps presented here illustrate the geochemistry of “S” soil samples, as analysed for pH (CaCl_2), for LOI at 450°C and for inorganic elements analysed by ICP-MS/AES following acid digestion in *aqua regia*. The data have not been conditioned. No levelling of the data collected over different years or analysed by different laboratories has been undertaken. The lack of levelling means that discernible survey boundary effects may be observed for some elements but, in general, the maps provide a good regional-scale representation of geochemical variation in the northern half of Ireland, having regard to the limits of the analytical method. Digestion of samples with *aqua regia* achieves only a partial extraction for most elements, especially those in less soluble minerals such as oxides and many silicates, so the true soil concentrations of many elements reported here are understated. The observed spatial distributions of elements thus reflect not only the bulk composition of the soil samples but also the ease of extraction of elements.

The greater density of soil samples in the Dublin and Galway periurban areas can lead to skewing of the statistics on which the map classes are based, affecting the distribution of values for some elements across the region. In order to create a more even and representative spread of sample points, for these areas the average concentration value was calculated for each $2 \text{ km} \times 2 \text{ km}$ grid cell, so that the interpolated maps are based on the same $1\text{-per-}4 \text{ km}^2$ sample density across the entire region.

The interpolation method employed to produce the maps was Inverse Distance Weighting (IDW), with a cell size of 250 m and a standard circular search radius of 2,000 m. The maps are presented with linework from the GSI 1:1,000,000 Bedrock Geology map (Figure 2).



1.3. References

Knights, K.V., Szpak, M., Mather, J. and Collins, L. (2020). Tellus geochemical survey: deeper topsoil data from outer Dublin, the border, north, and west of Ireland, Geological Survey Ireland, March 2020

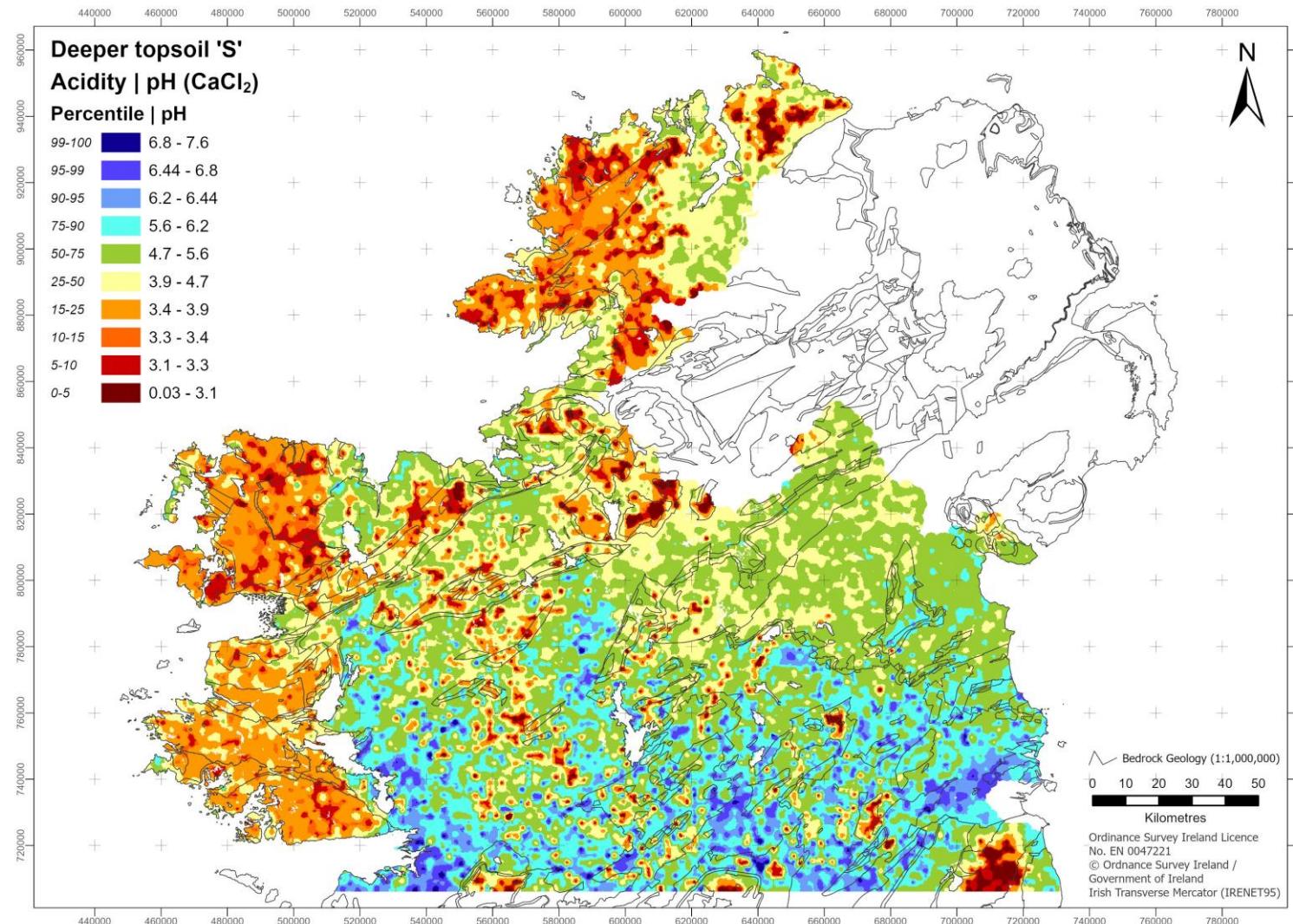
Szpak, M., Gallagher, V., Mather, J. and Knights, K.V. (2021). Tellus geochemical survey: deeper topsoil data from the midlands of Ireland, Geological Survey Ireland, April 2021



2. Deeper topsoil ‘S’ maps

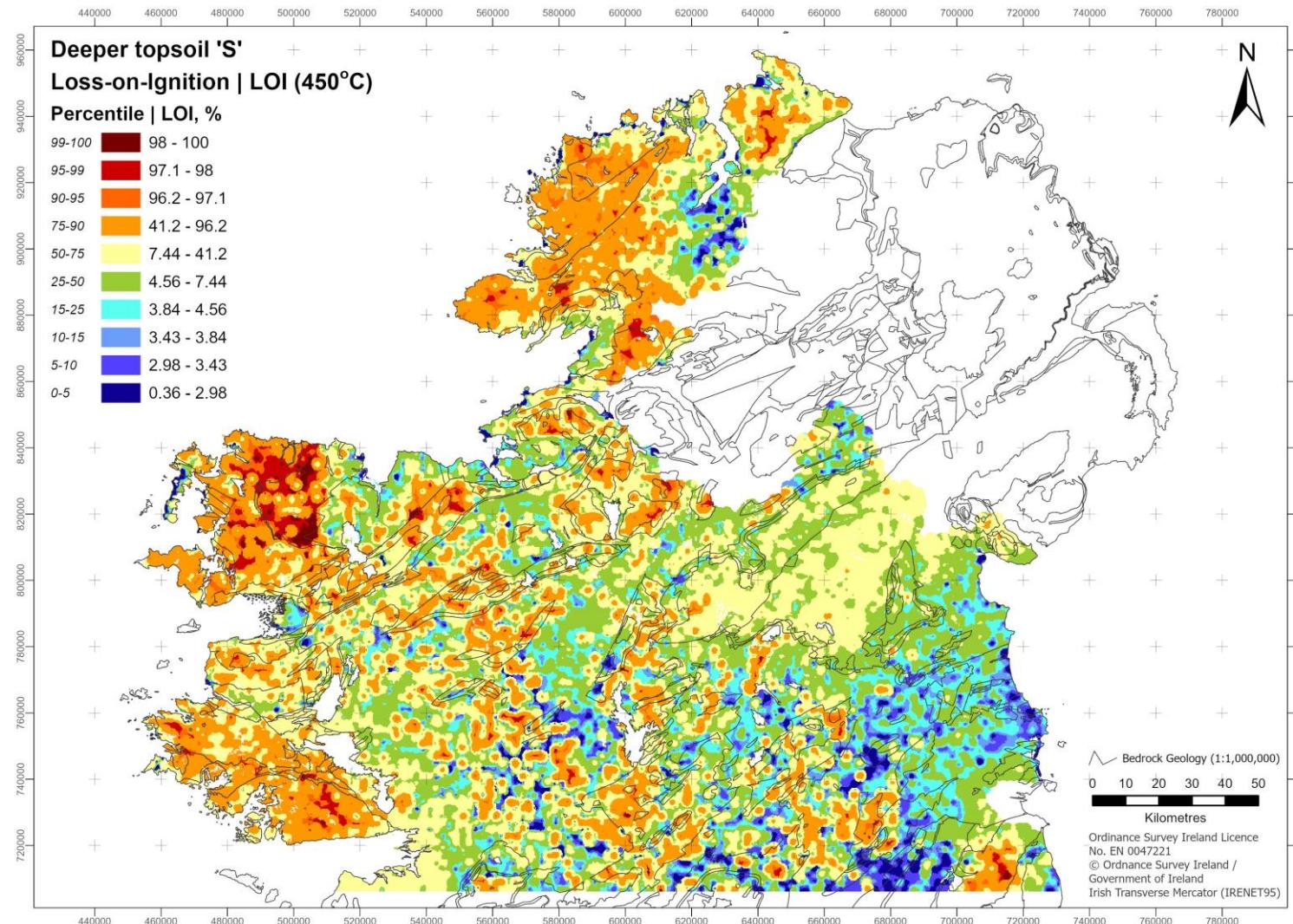


2.1. Soil pH



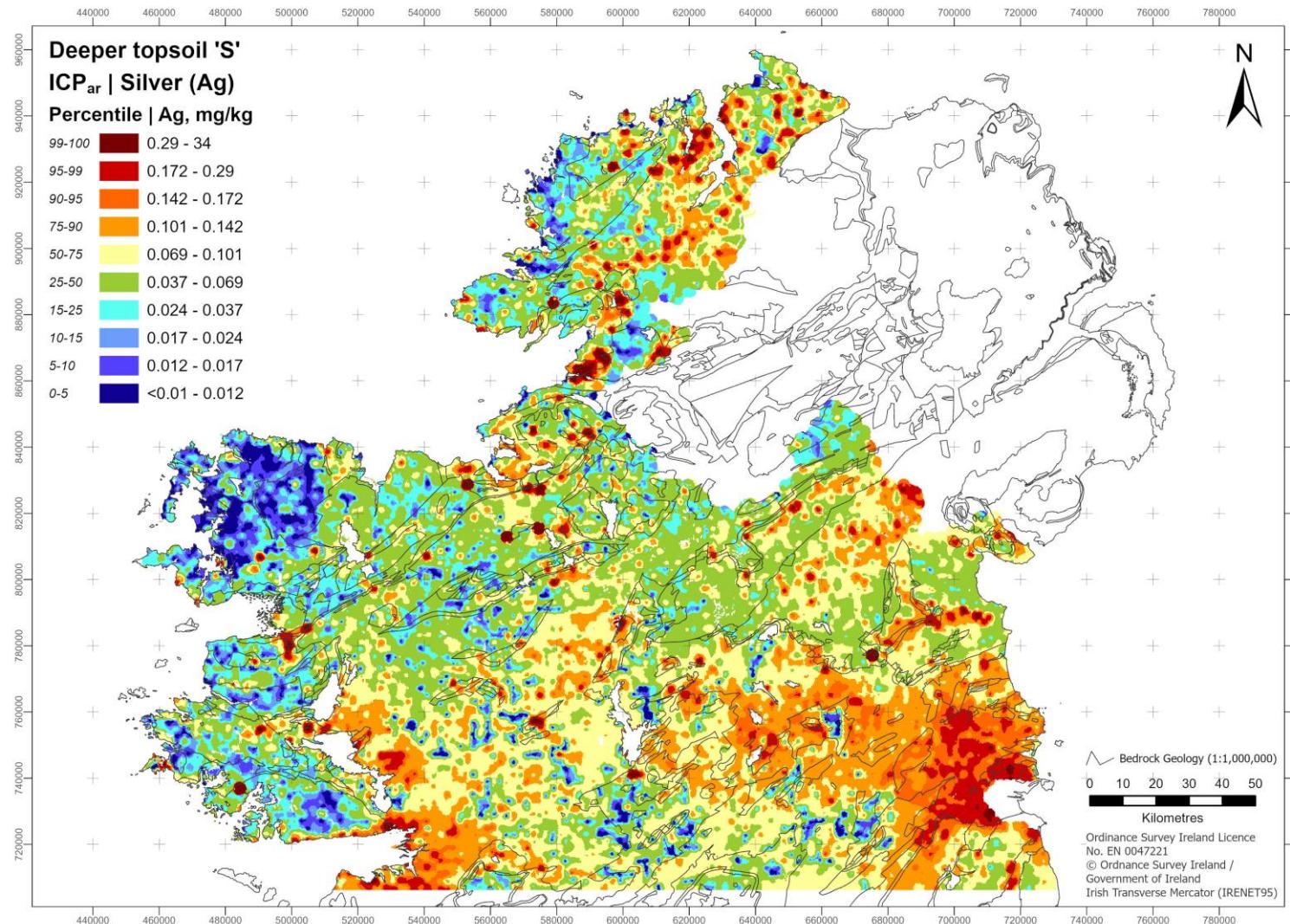
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2.2. Loss-on-Ignition (LOI)



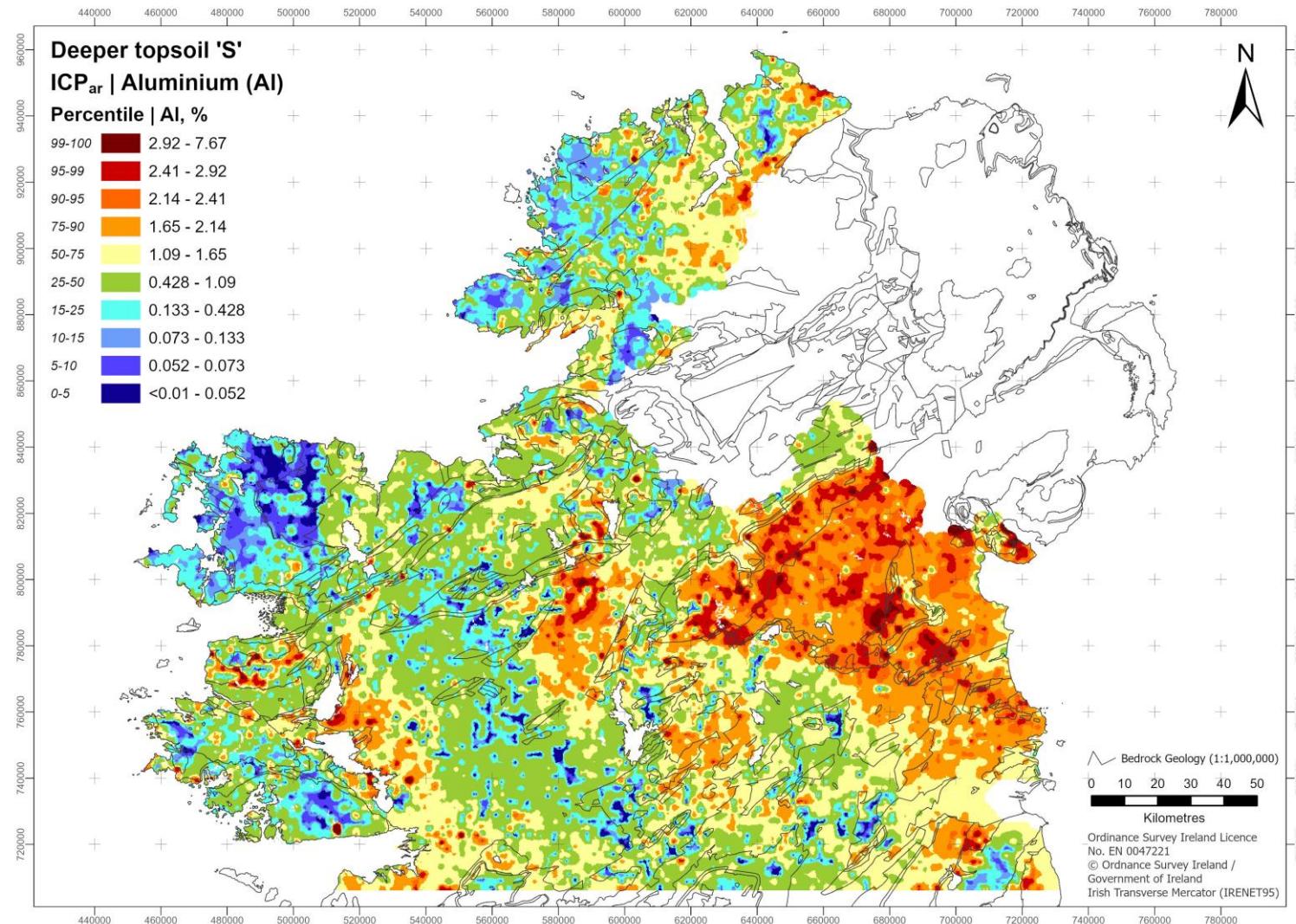
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2.3. Silver (Ag)



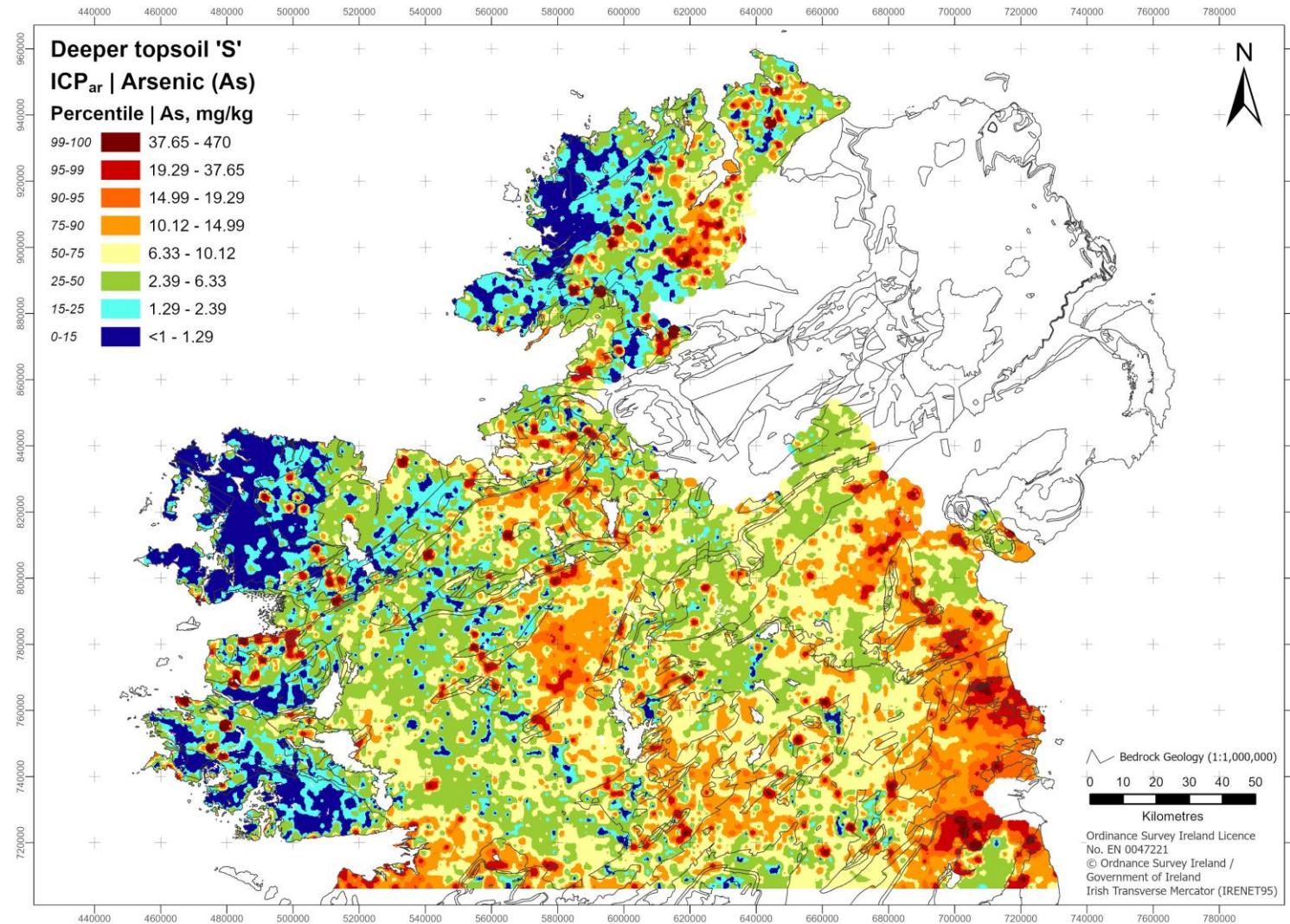
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2.4. Aluminium (Al)



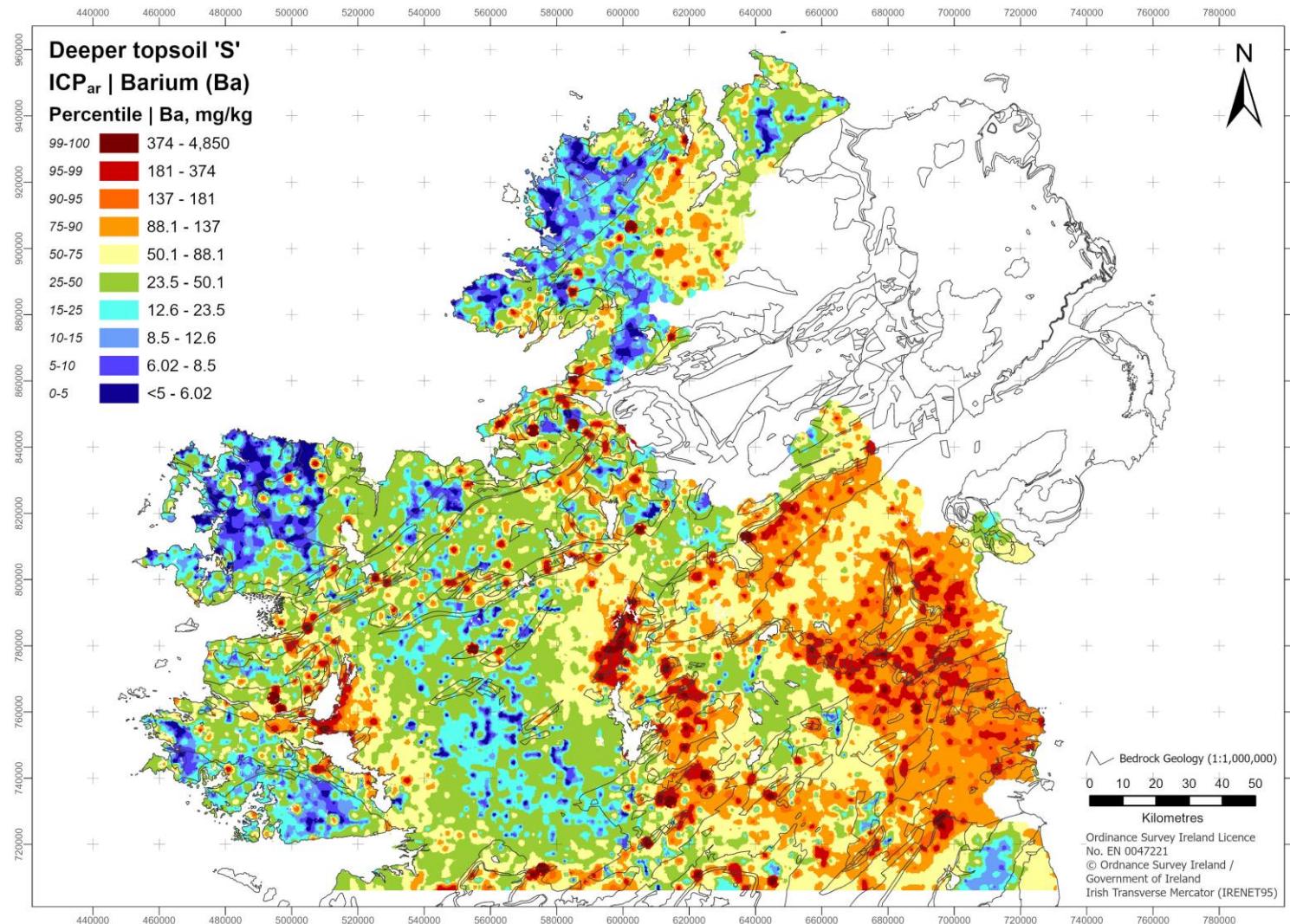
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2.5. Arsenic (As)



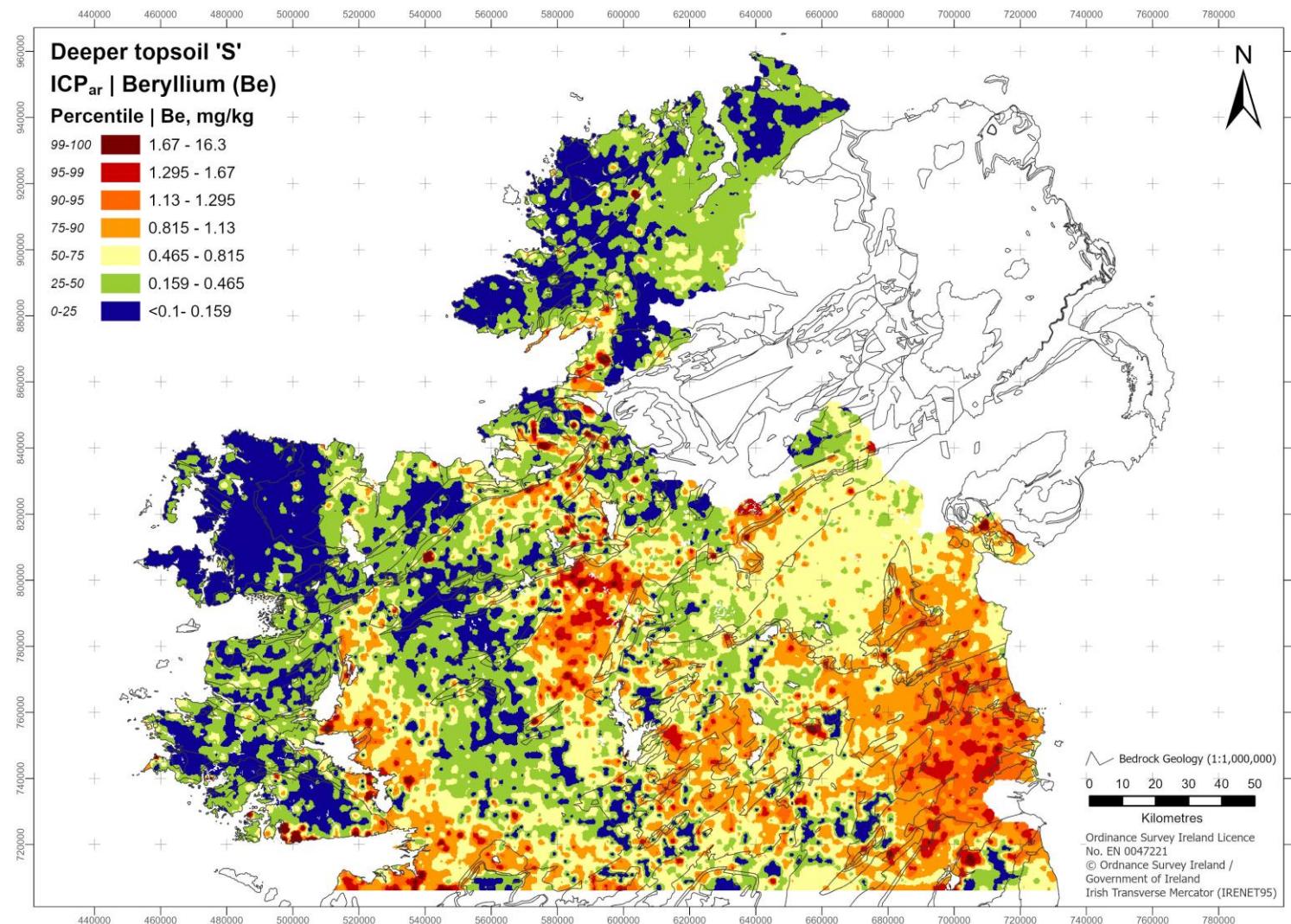
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2.6. Barium (Ba)



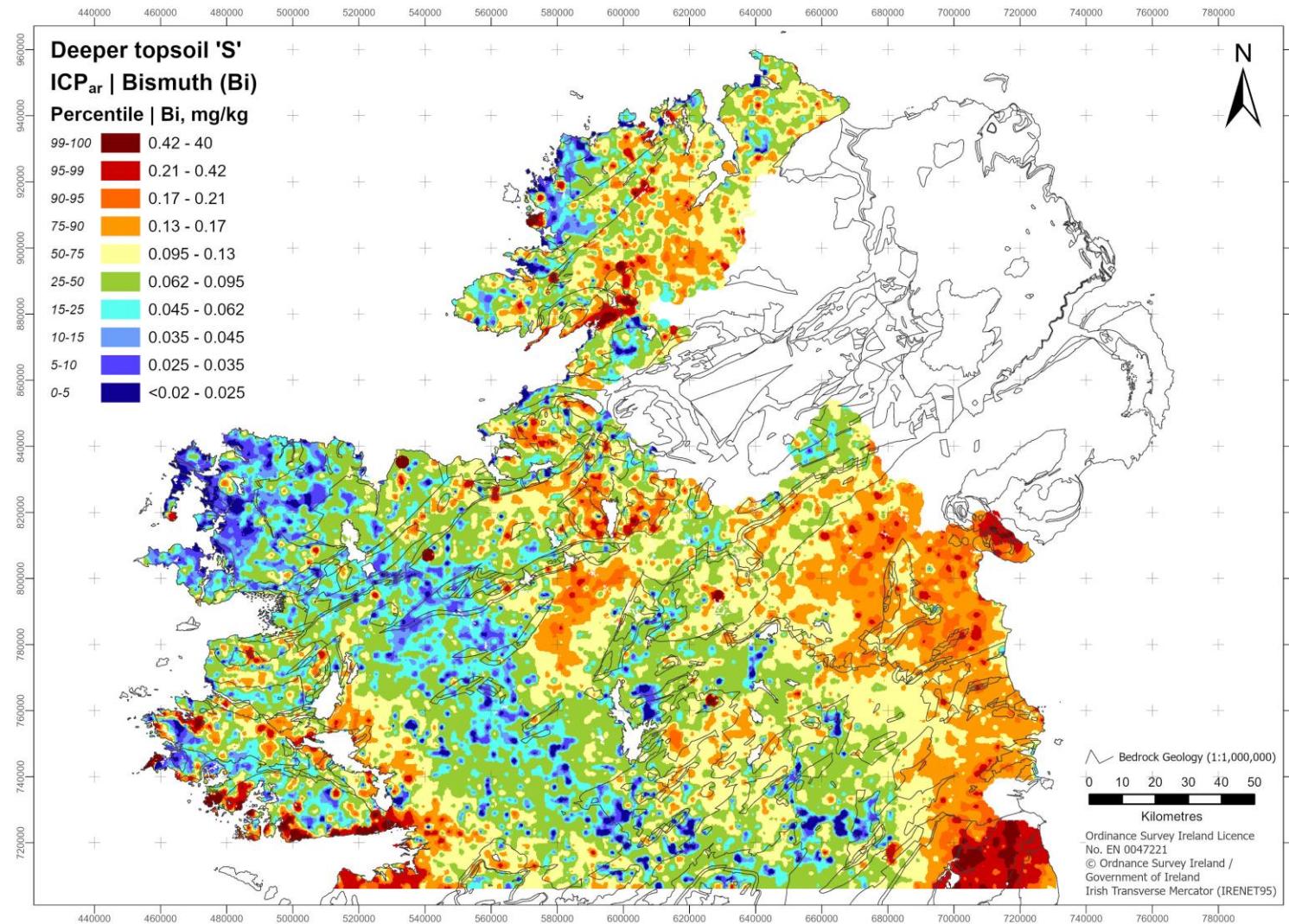
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2.7. Beryllium (Be)



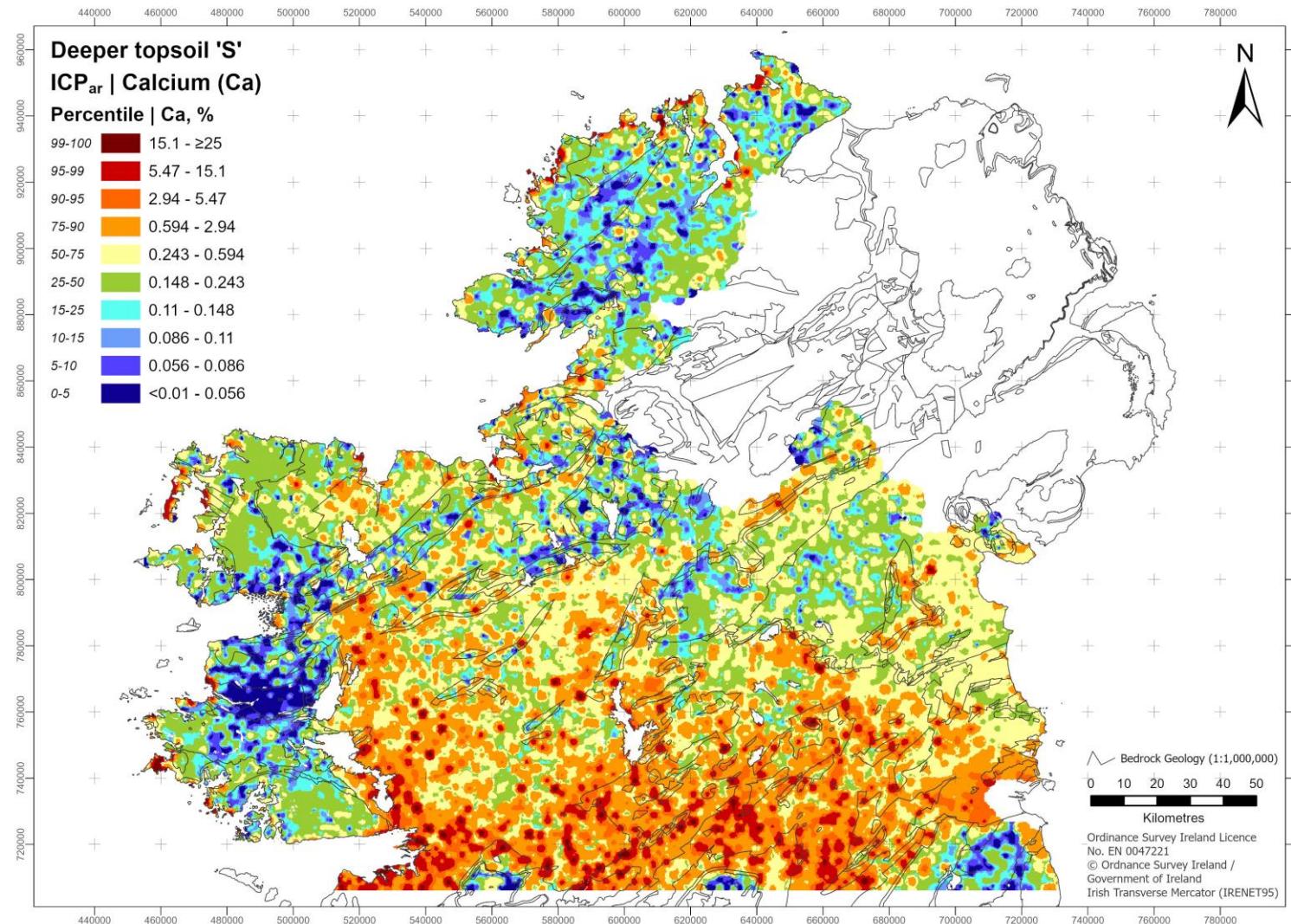
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2.8. Bismuth (Bi)



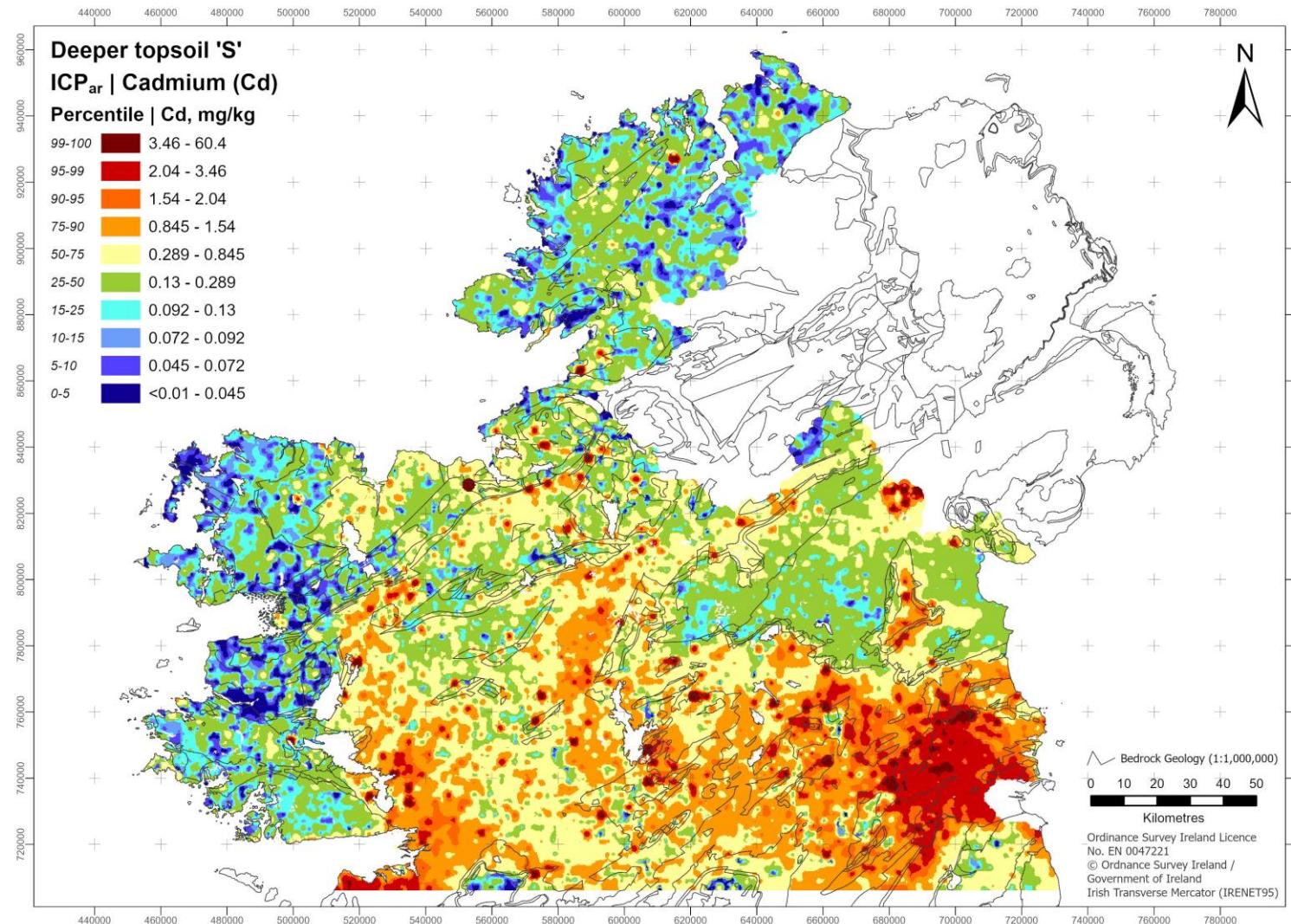
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2.9. Calcium (Ca)



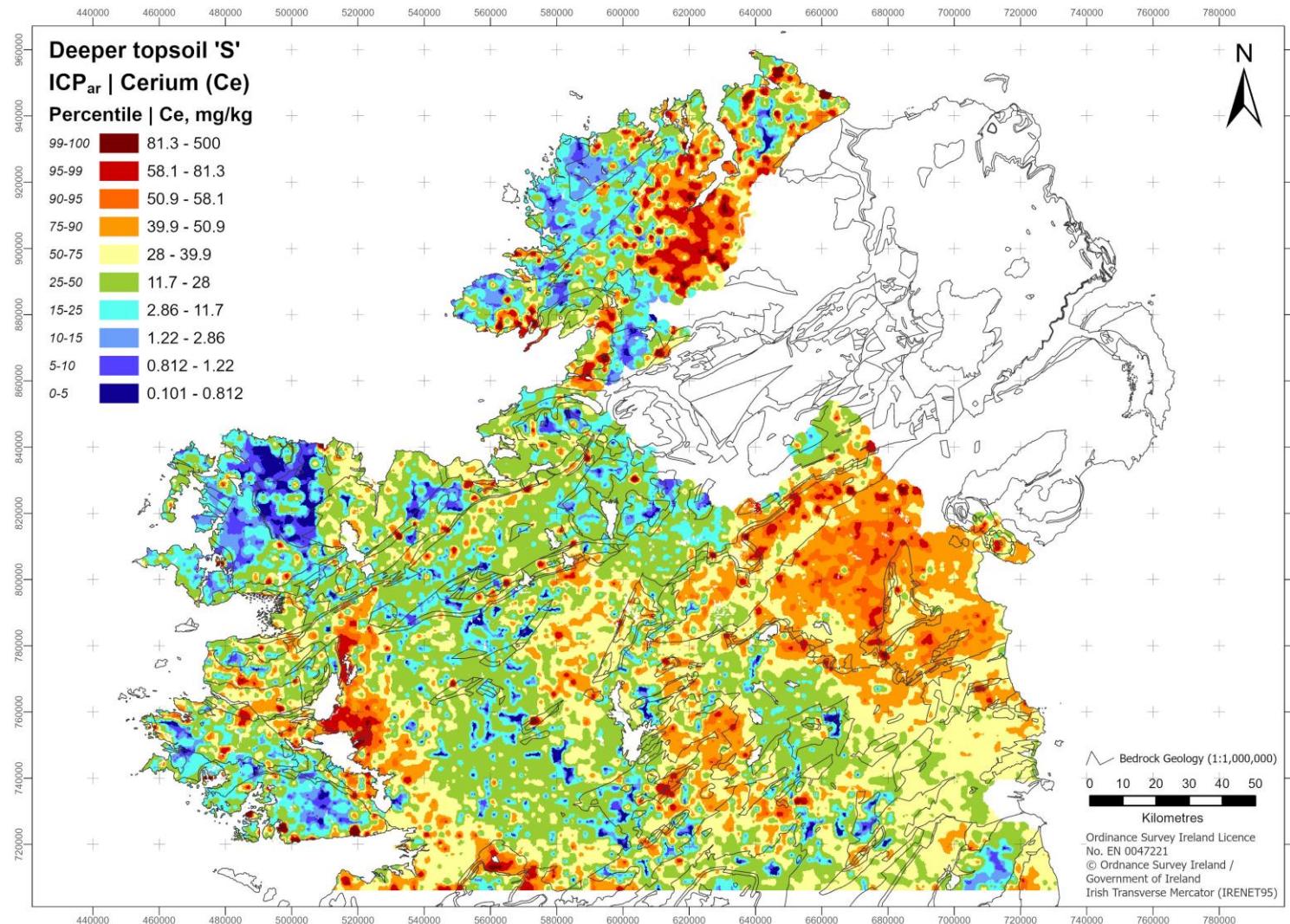
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2.10. Cadmium (Cd)



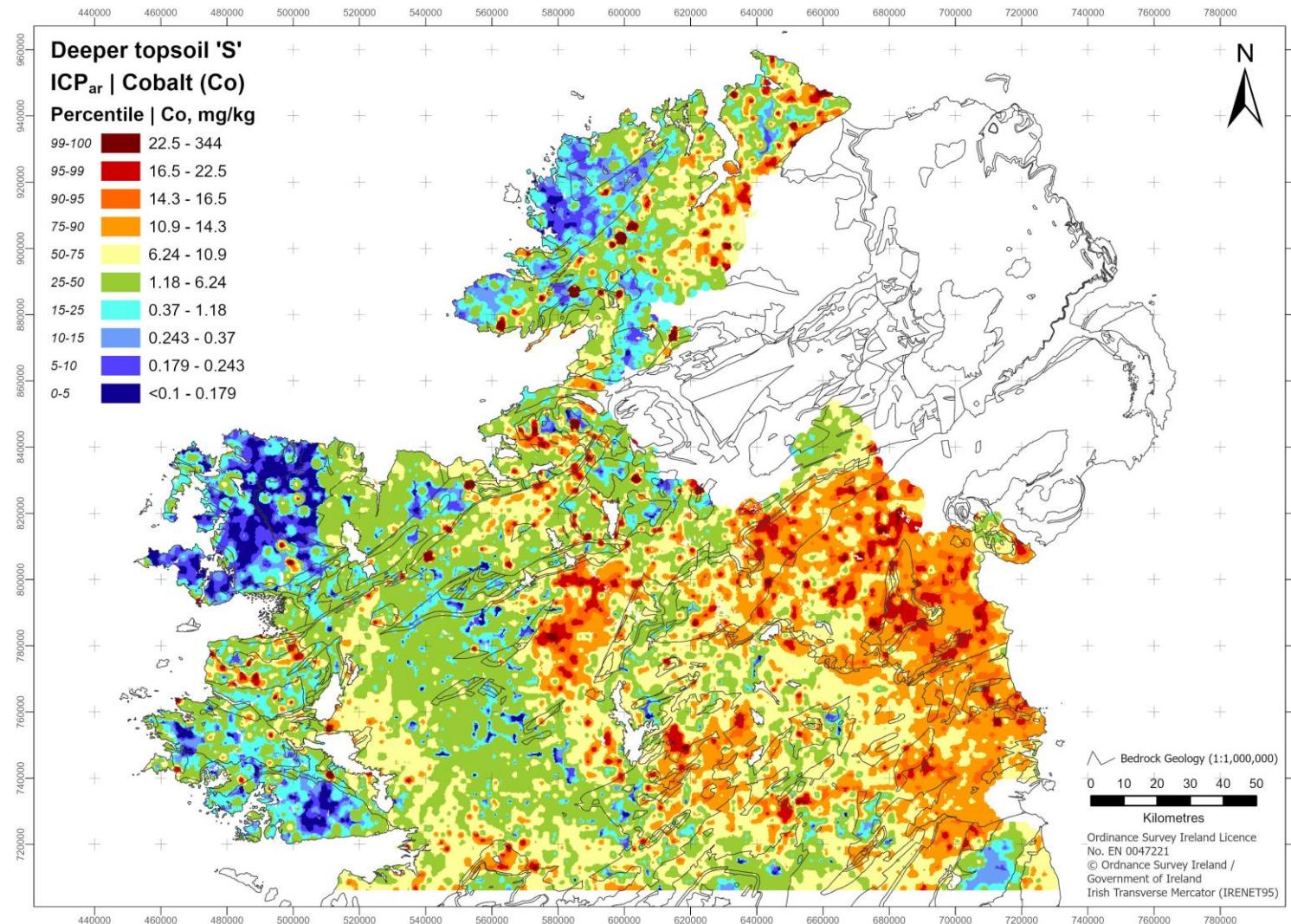
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2.11. Cerium (Ce)



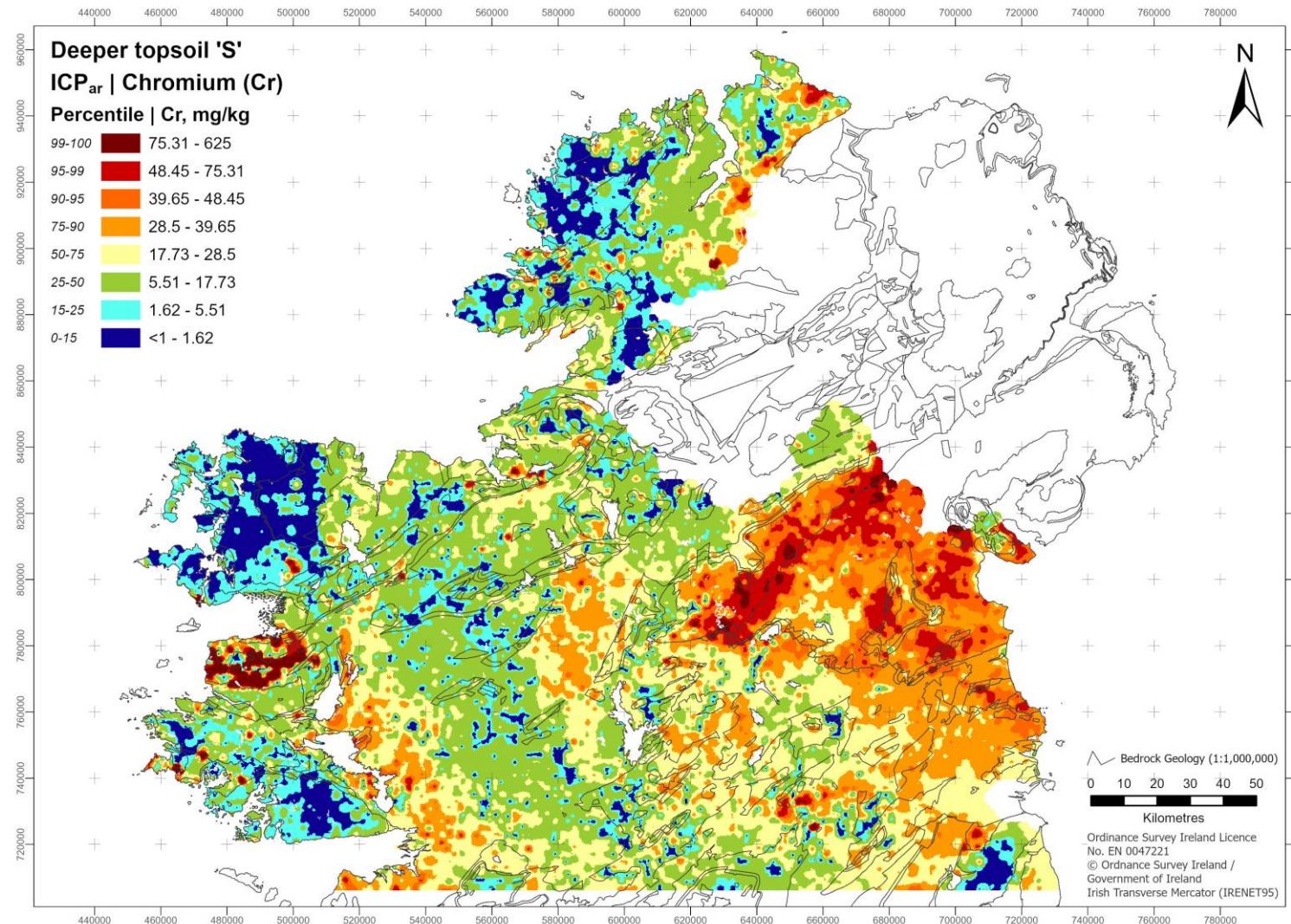
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2.12. Cobalt (Co)



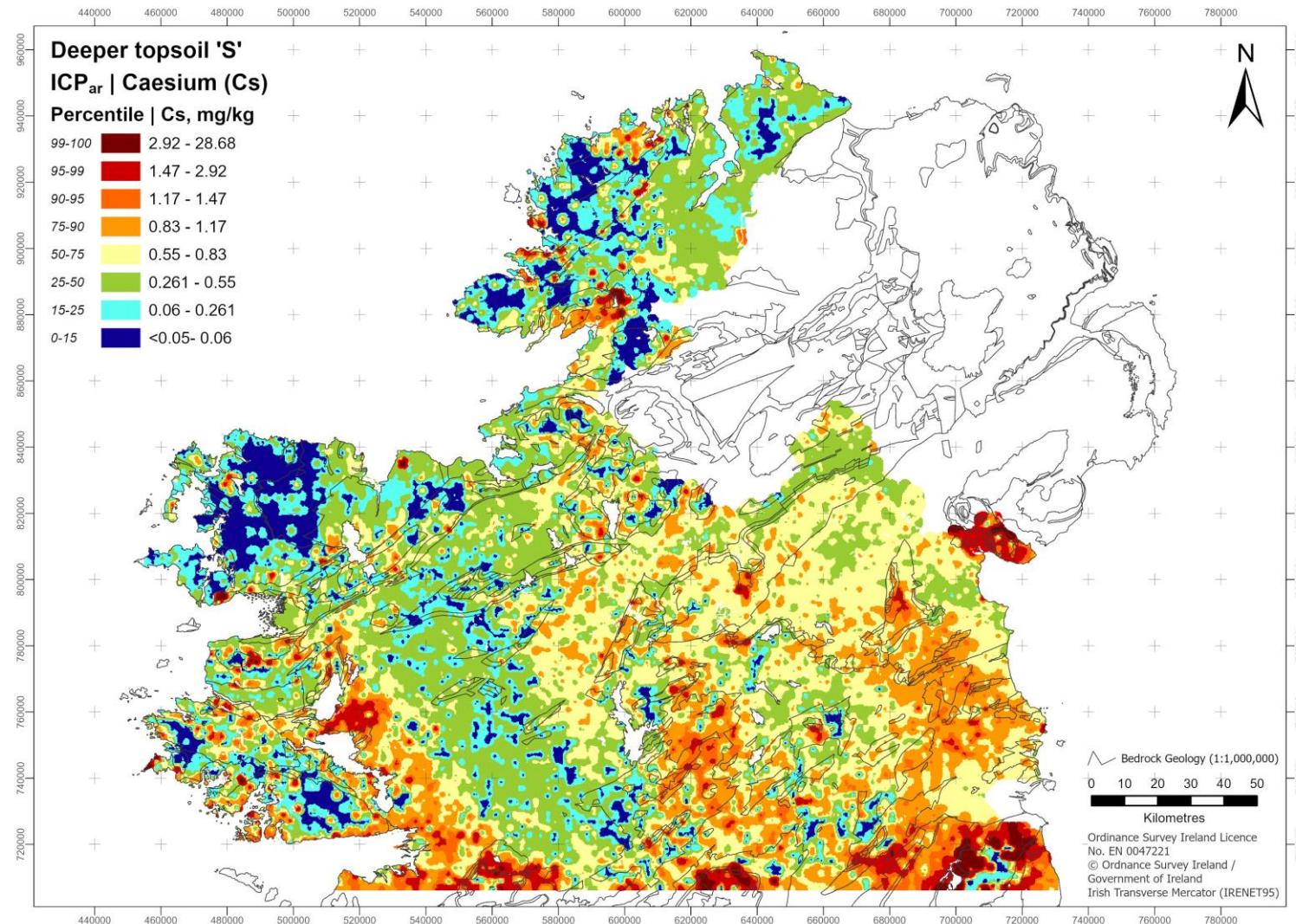
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2.13. Chromium (Cr)



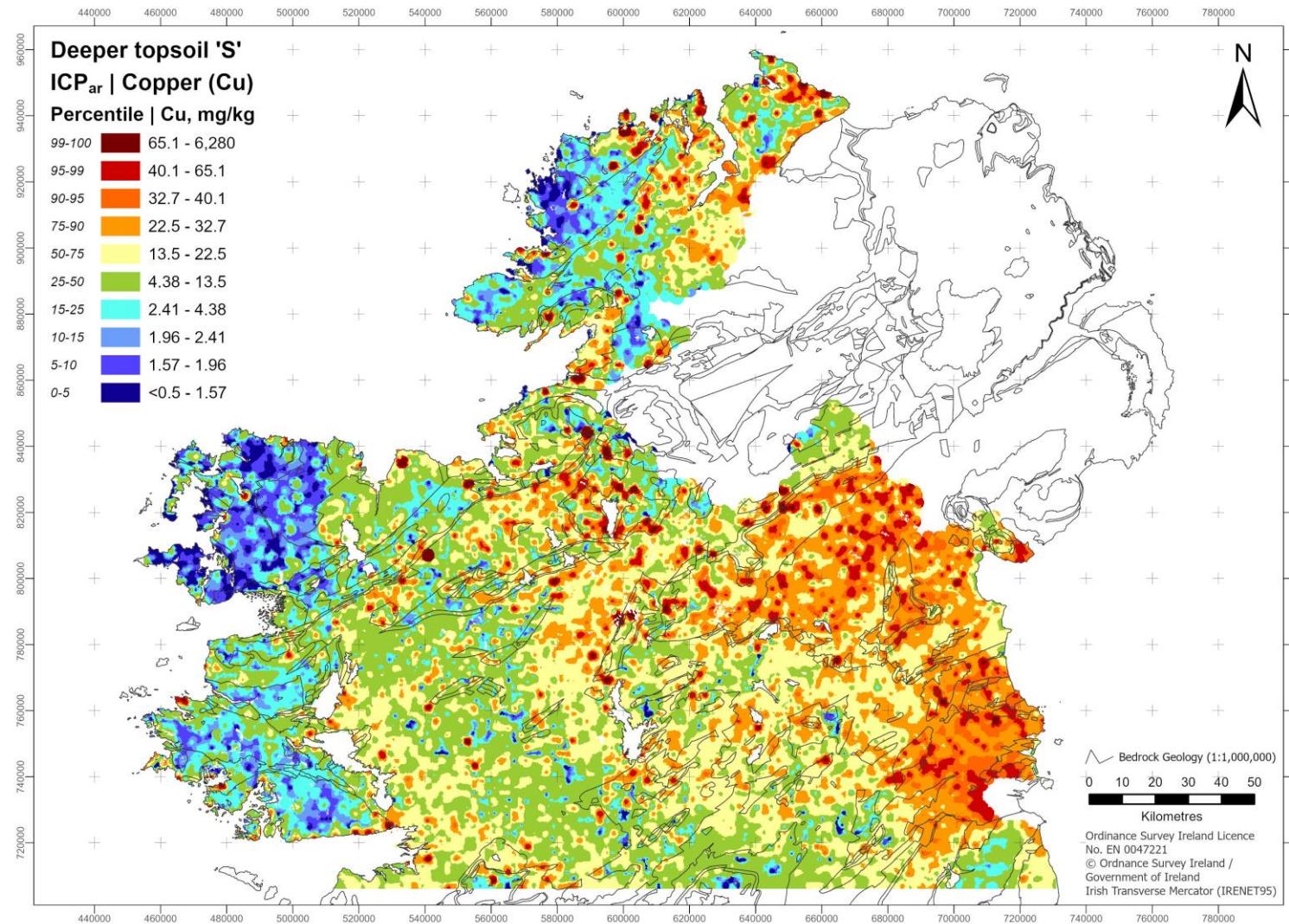
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2.14. Caesium (Cs)

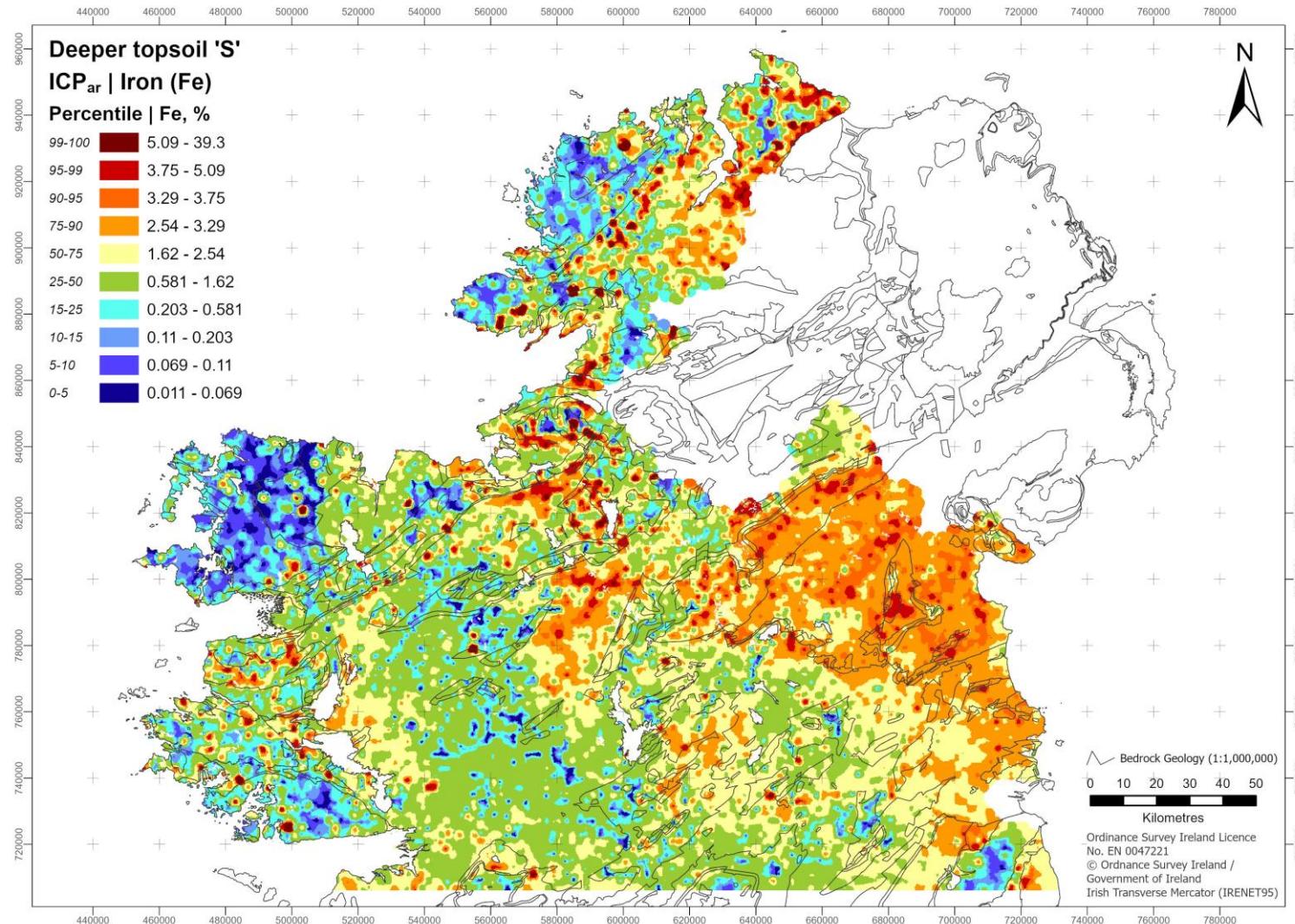


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2.15. Copper (Cu)

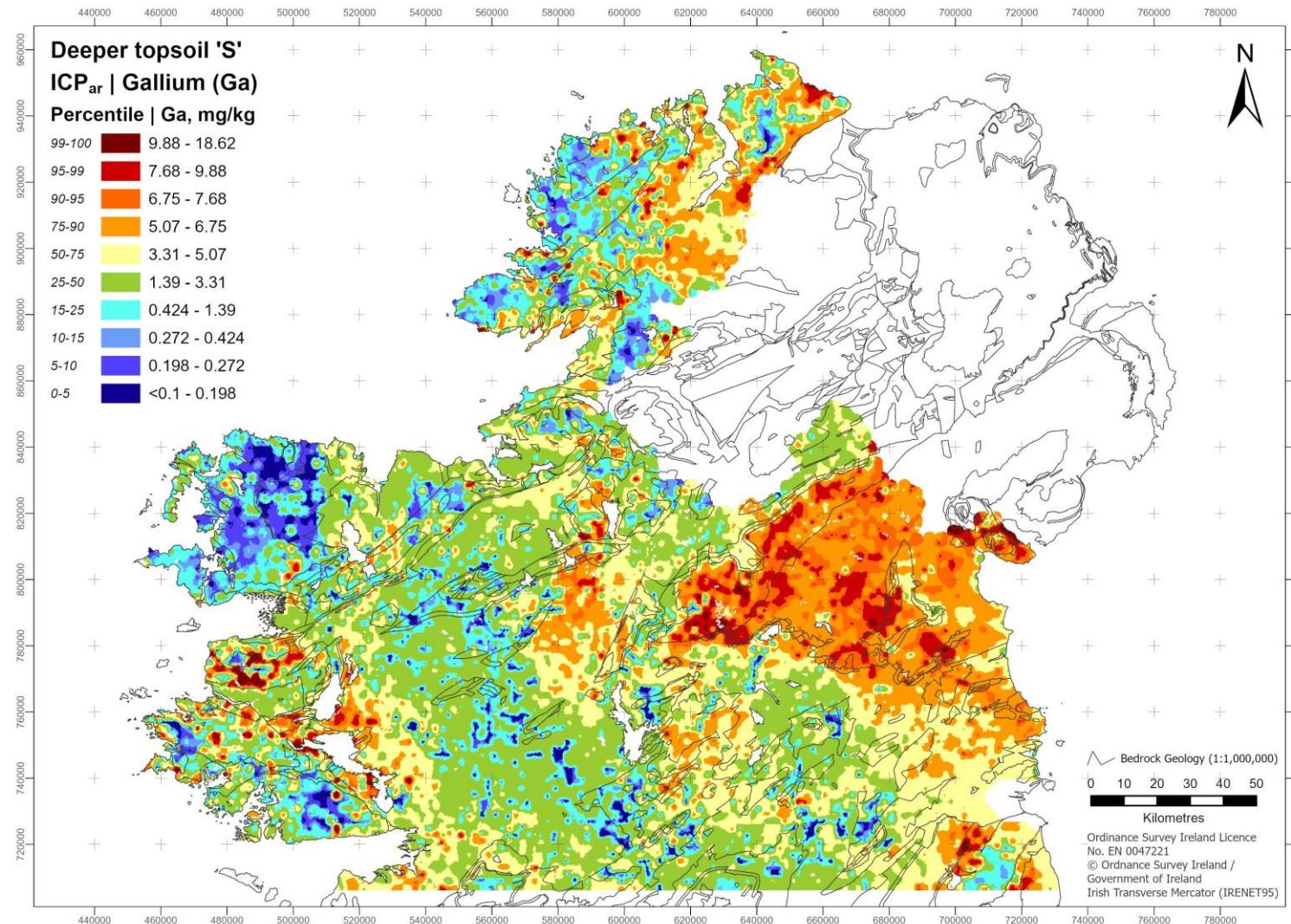


2.16. Iron (Fe)



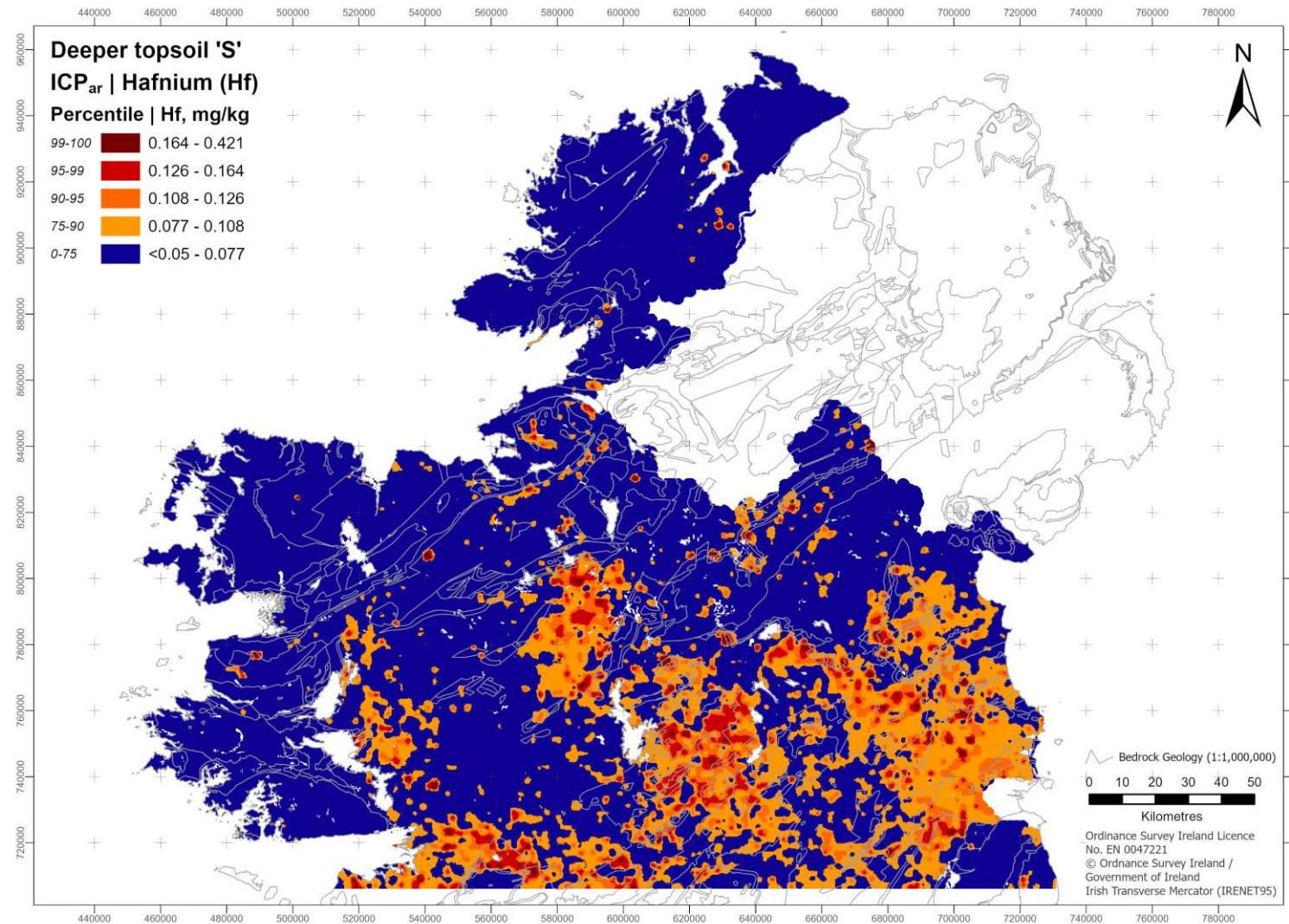
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2.17. Gallium (Ga)

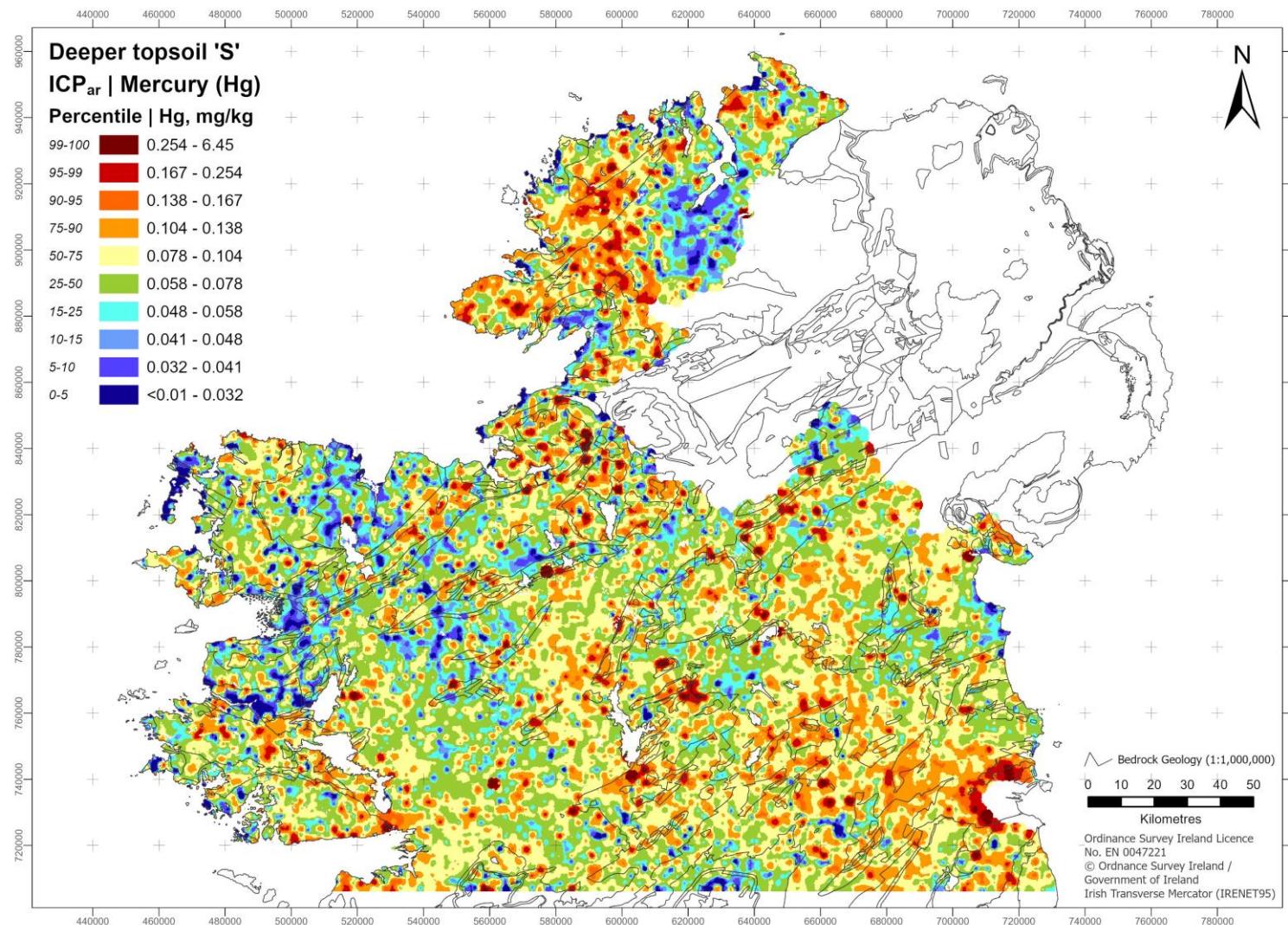


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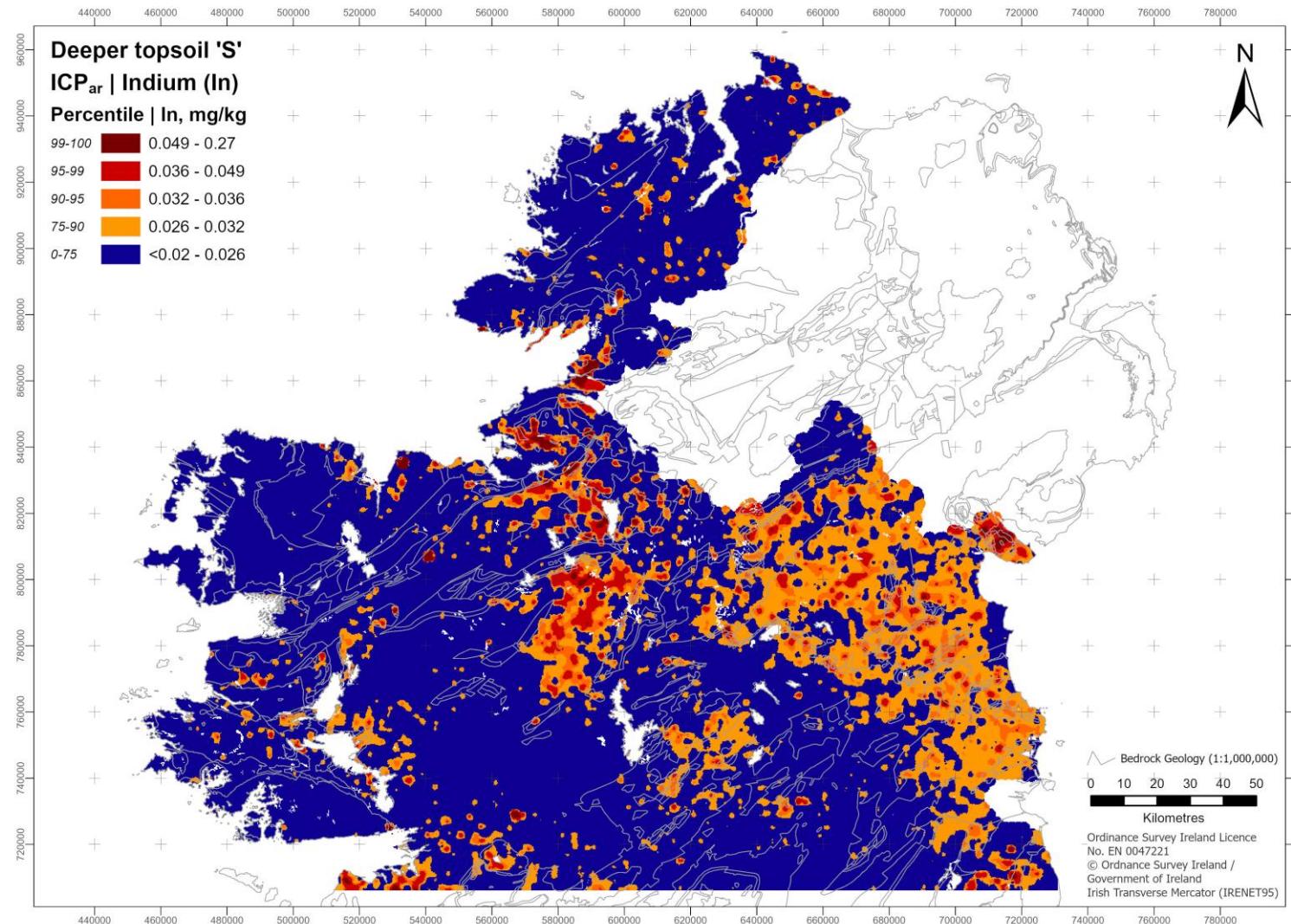
2.18. Hafnium (Hf)



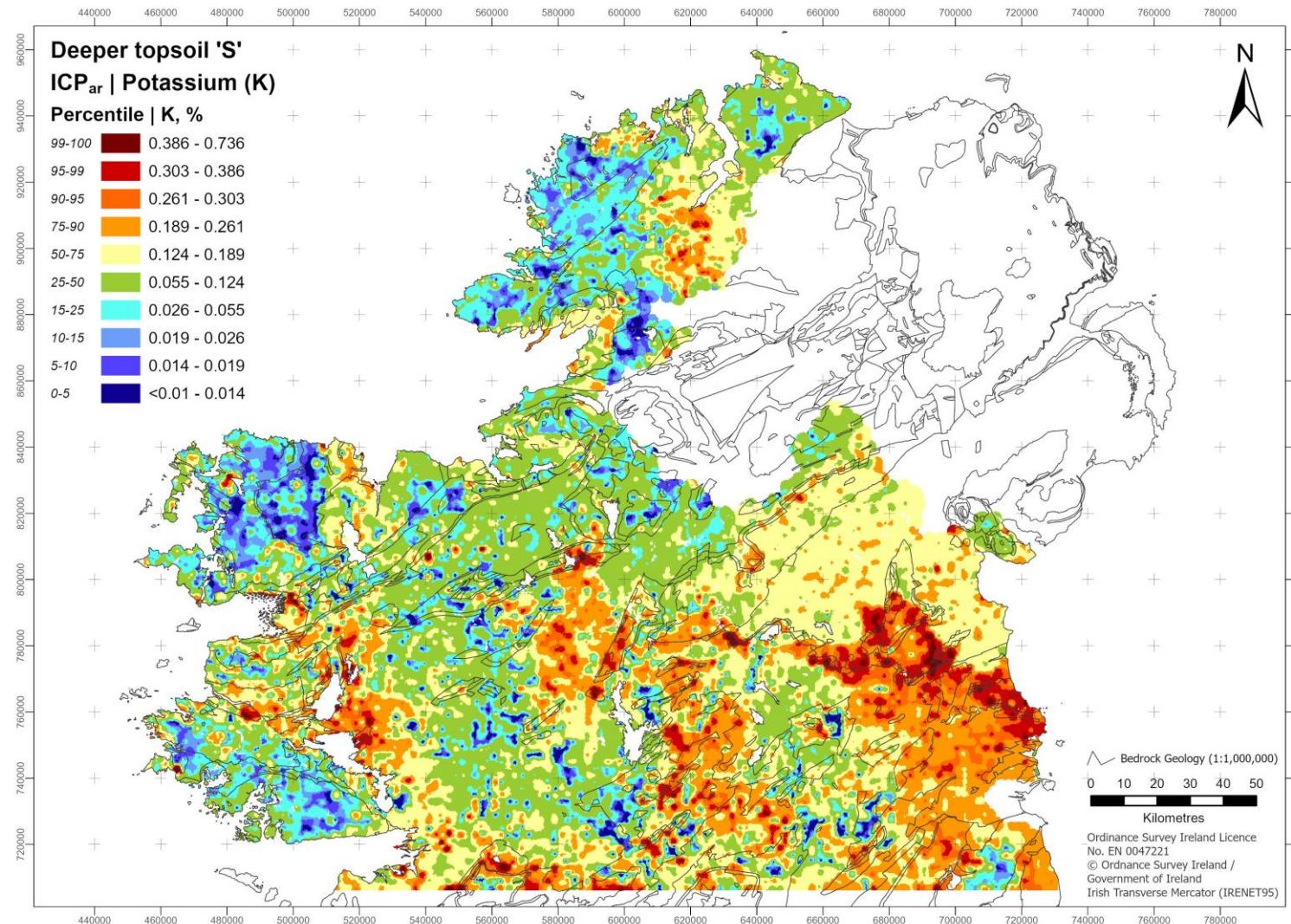
2.19. Mercury (Hg)



2.20. Indium (In)

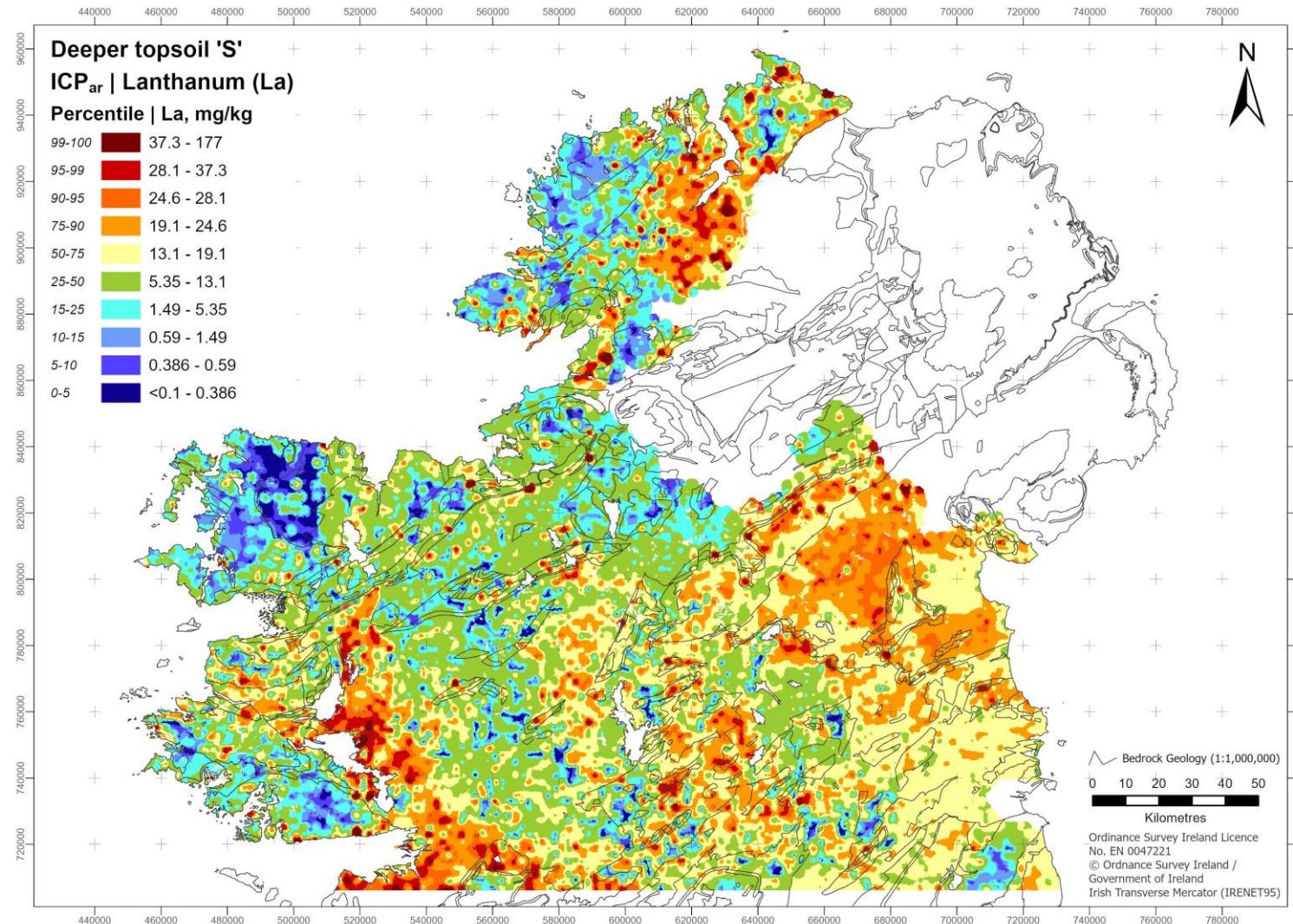


2.21. Potassium (K)



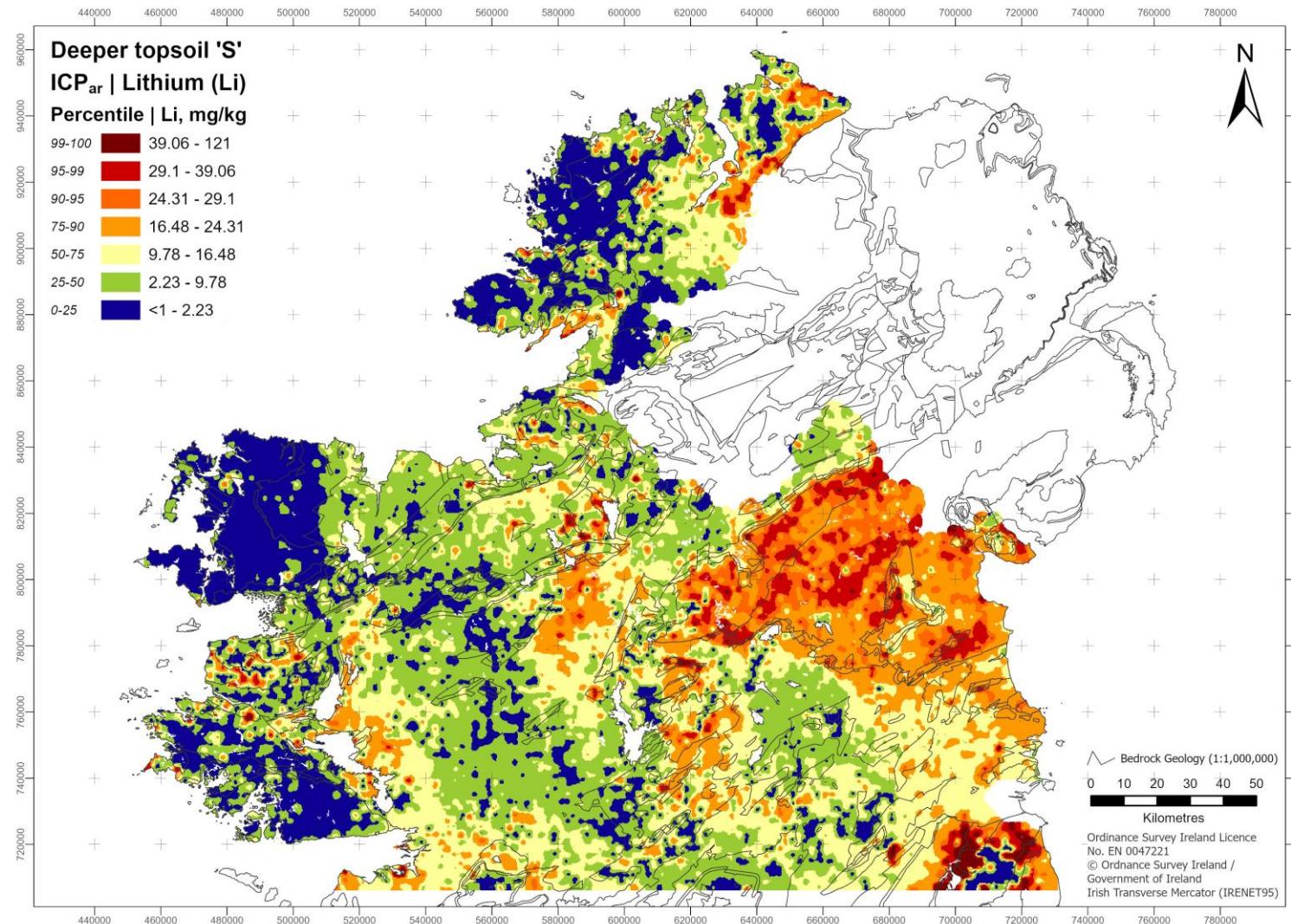
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2.22. Lanthanum (La)



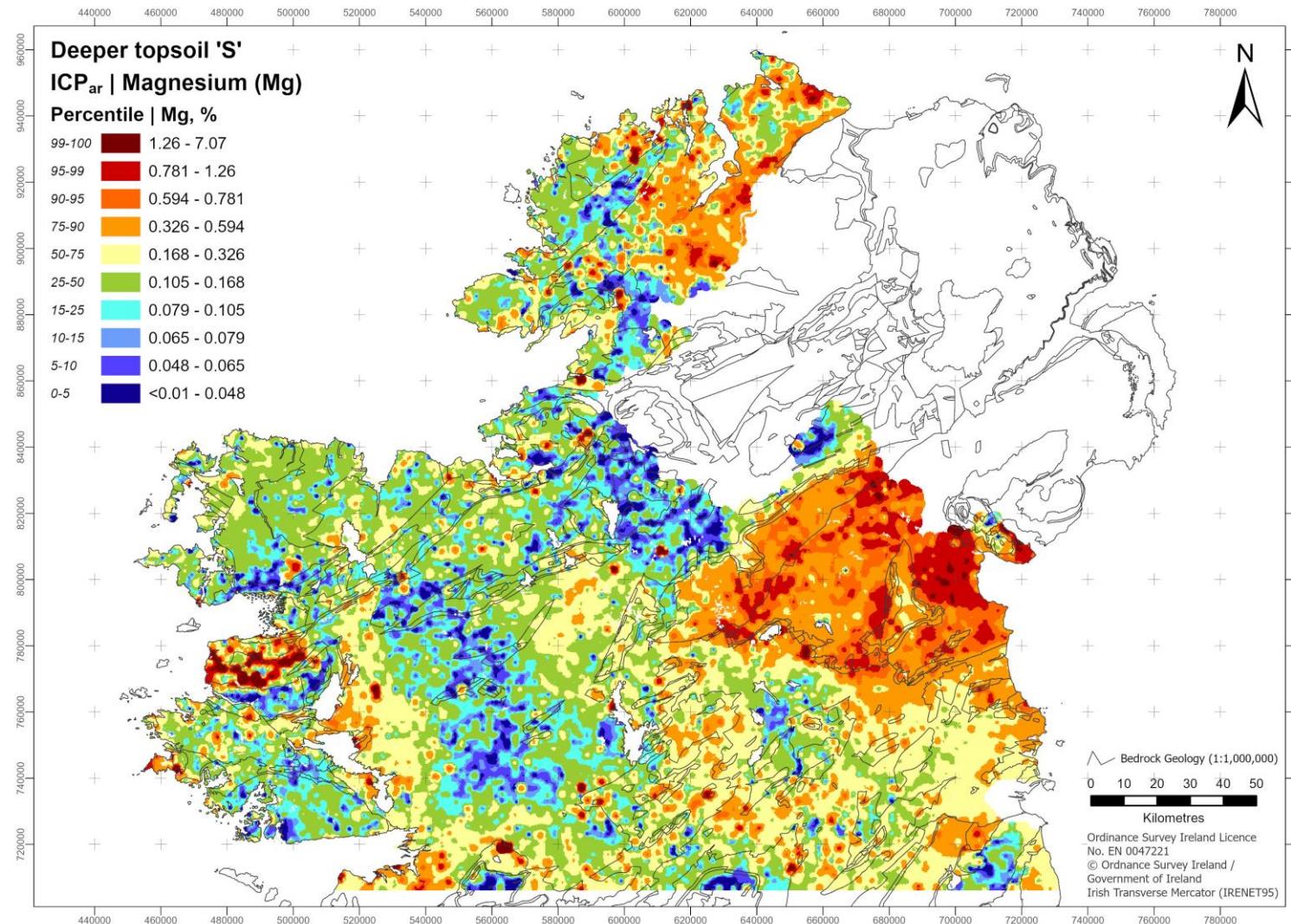
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2.23. Lithium (Li)



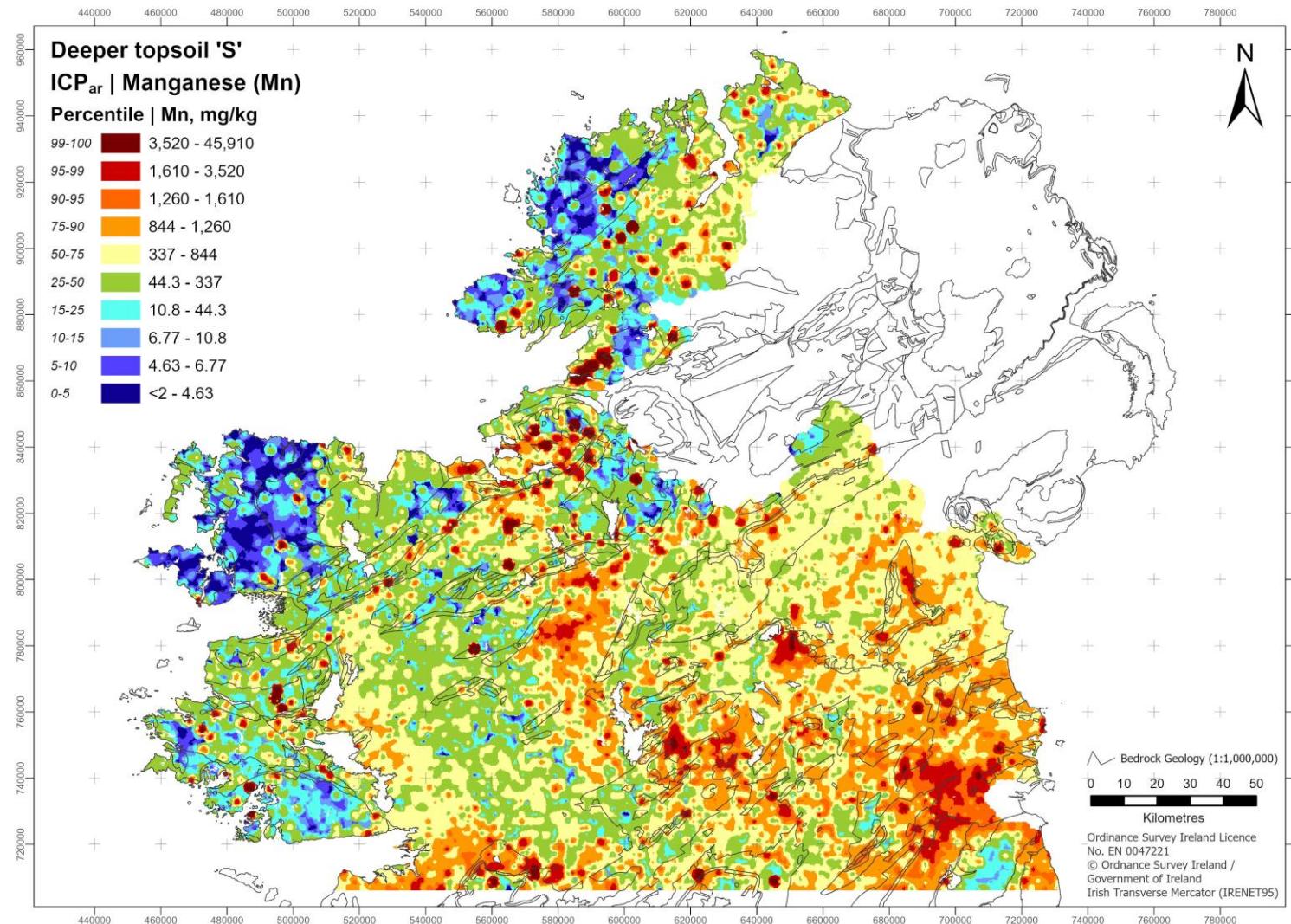
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2.24. Magnesium (Mg)

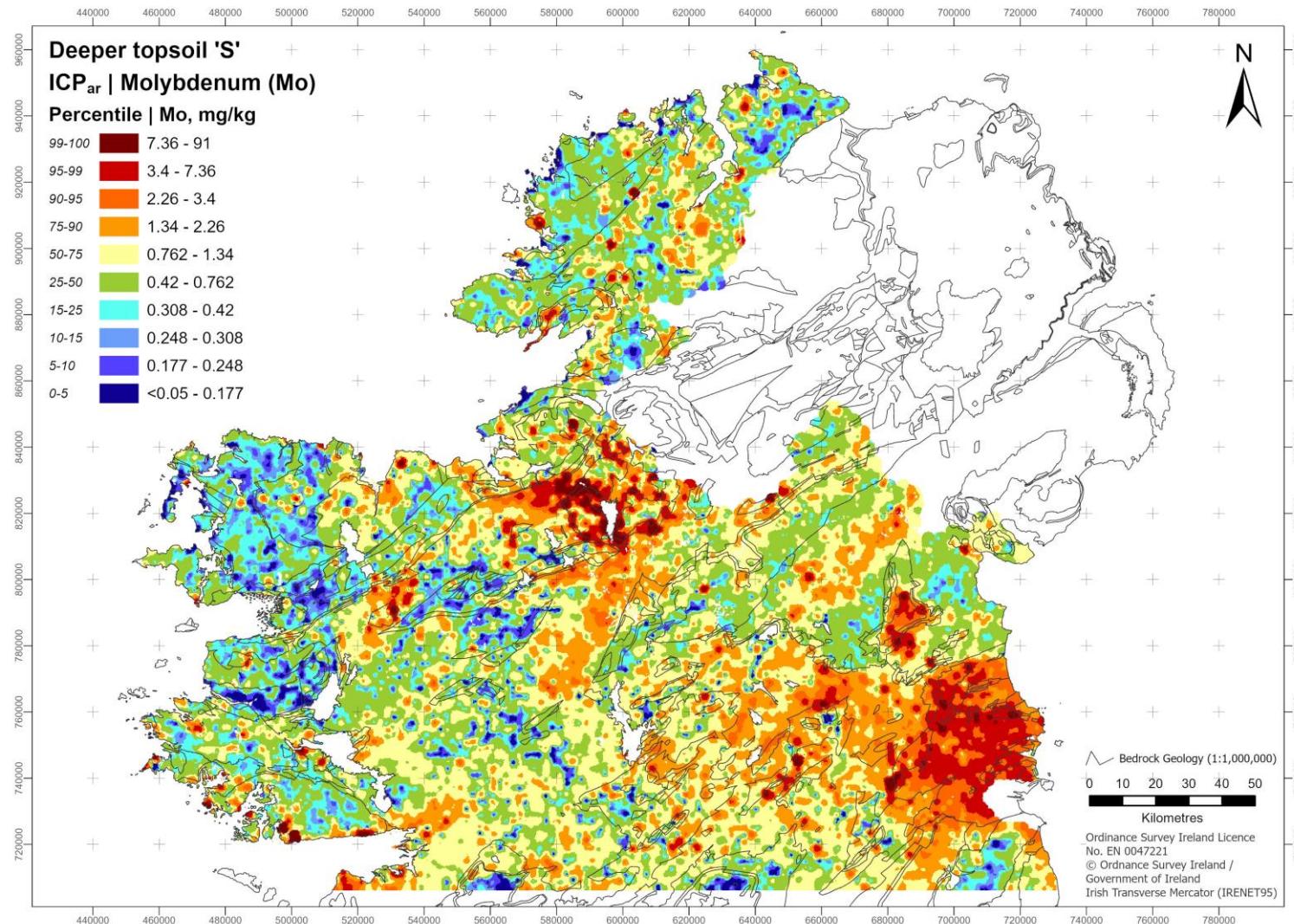


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2.25. Manganese (Mn)

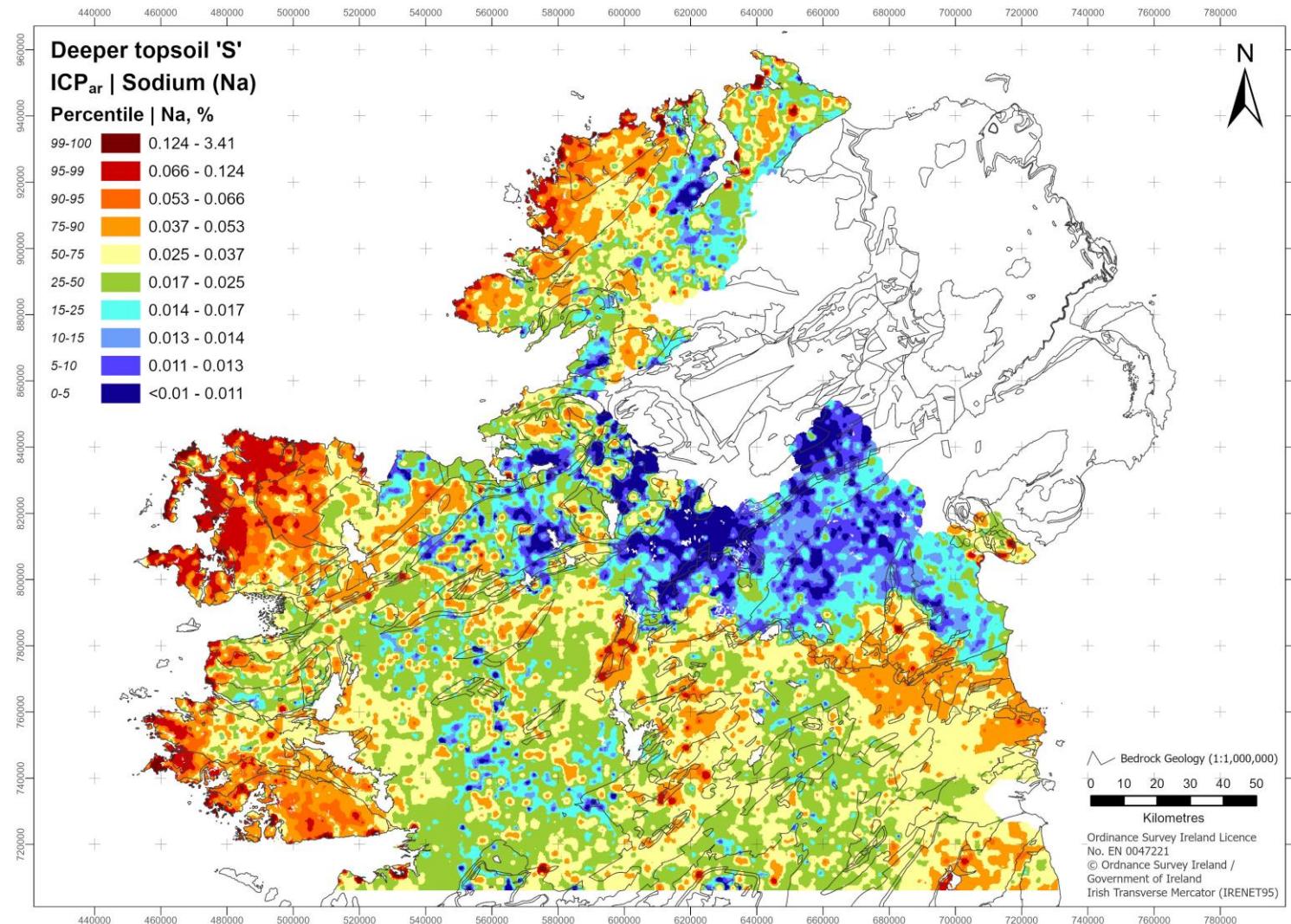


2.26. Molybdenum (Mo)

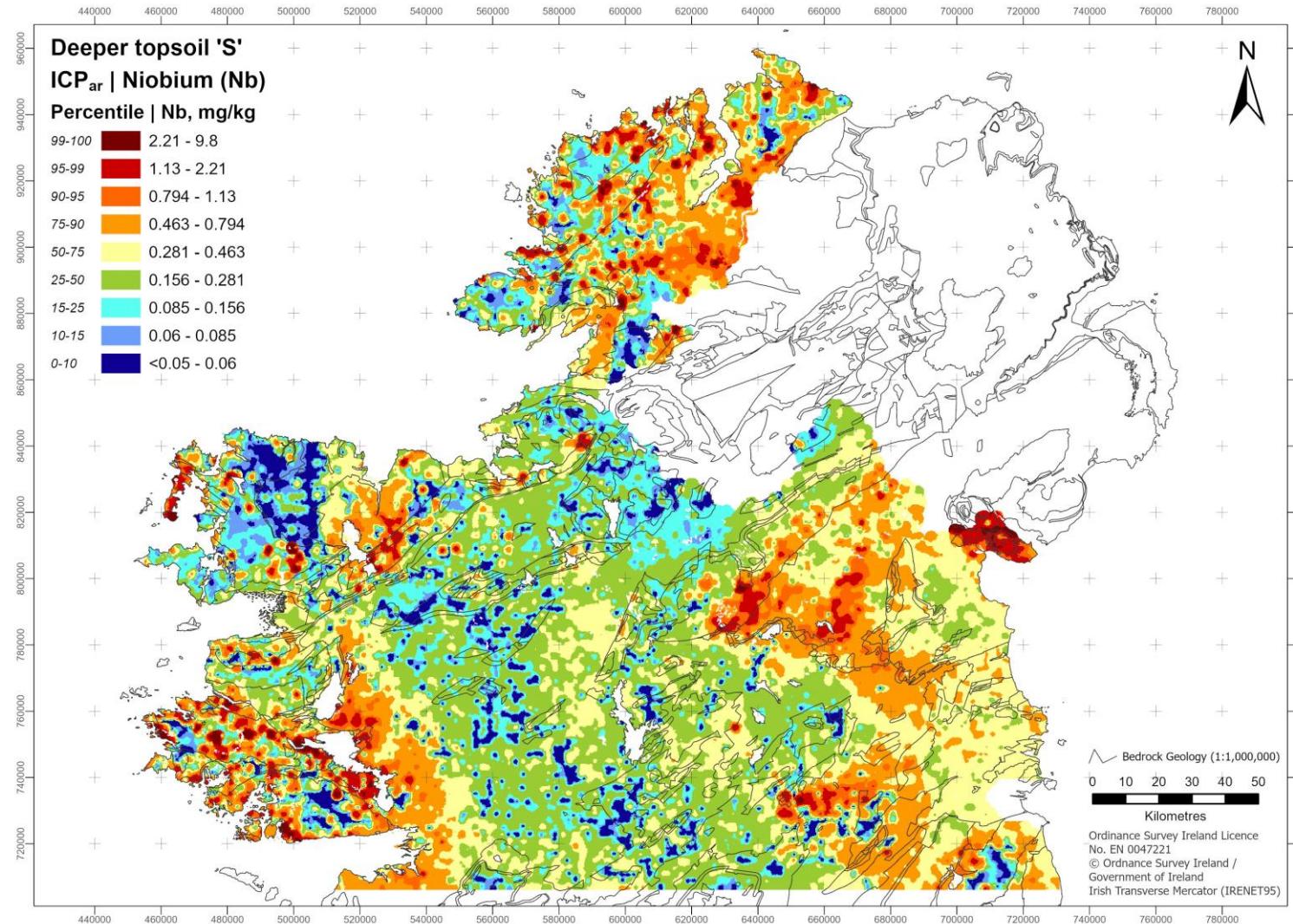


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2.27. Sodium (Na)

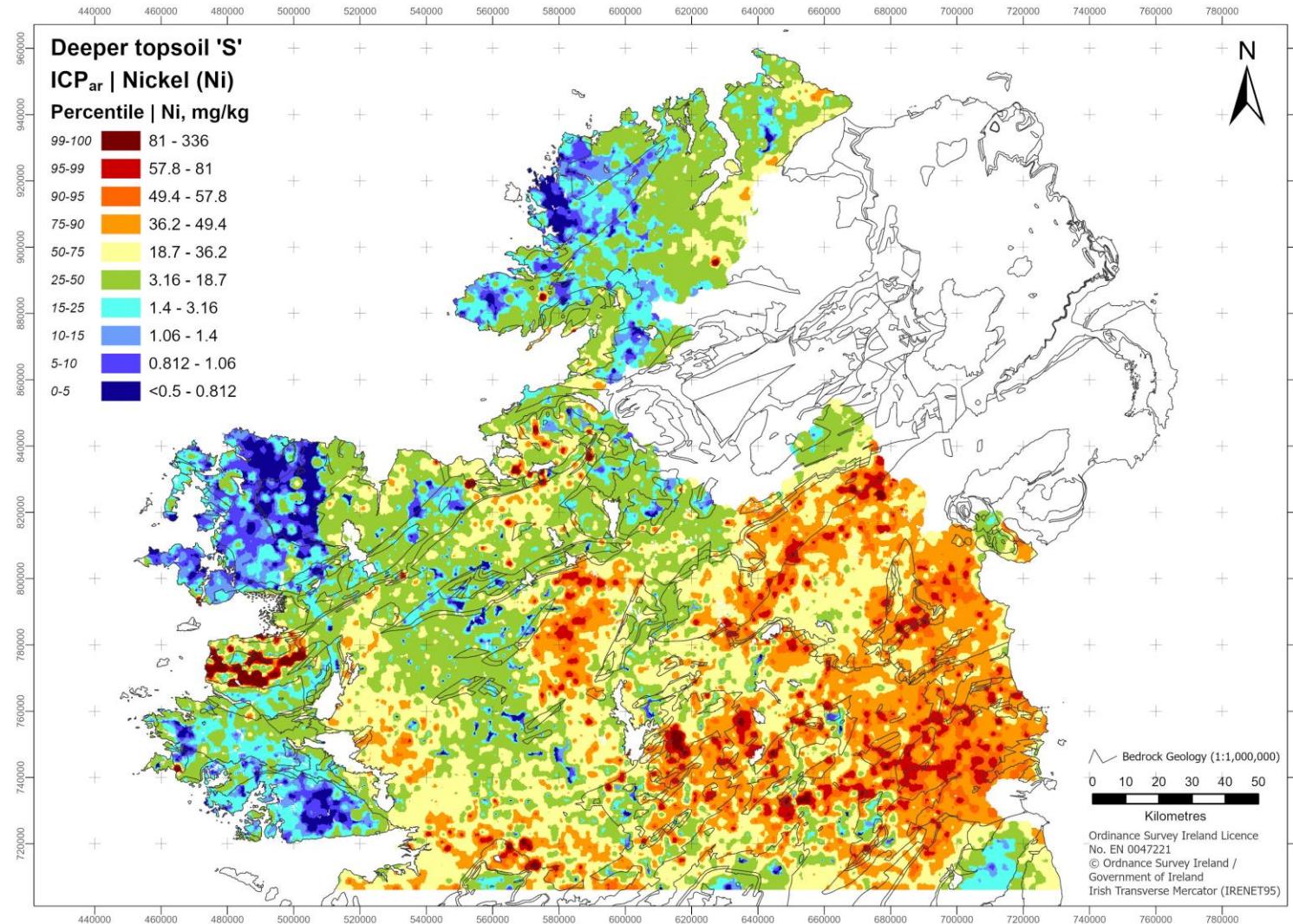


2.28. Niobium (Nb)



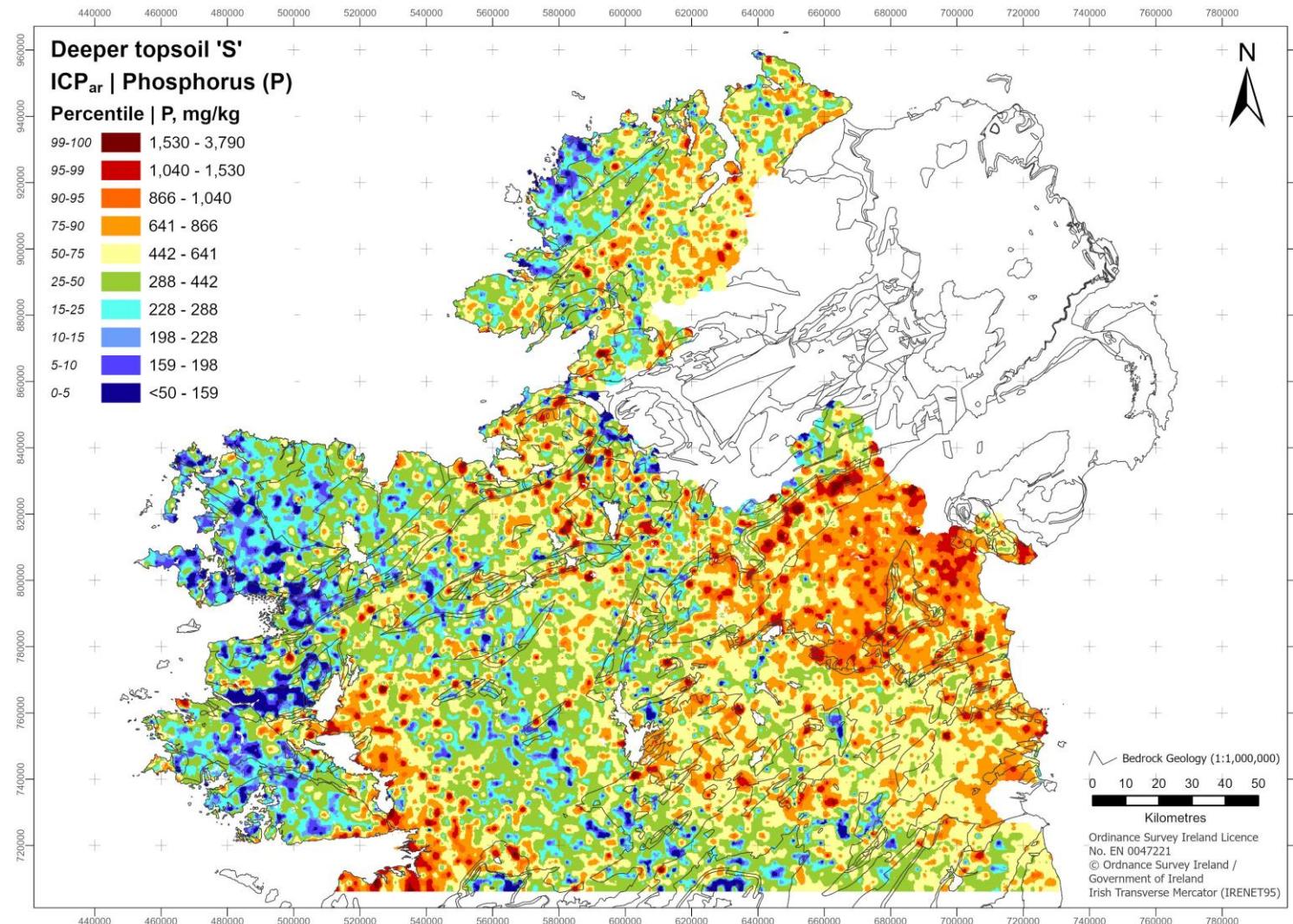
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2.29. Nickel (Ni)



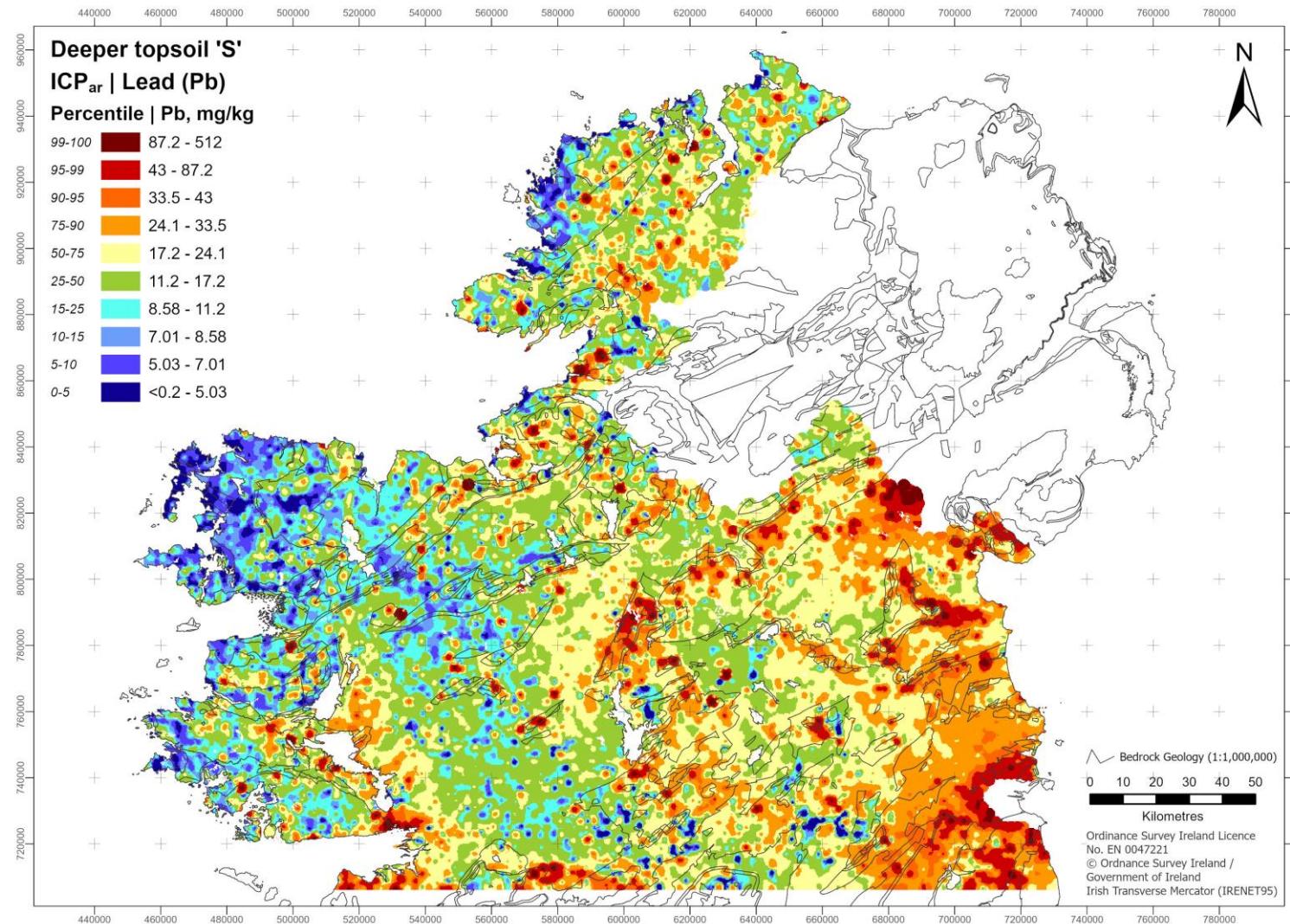
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2.30. Phosphorus (P)

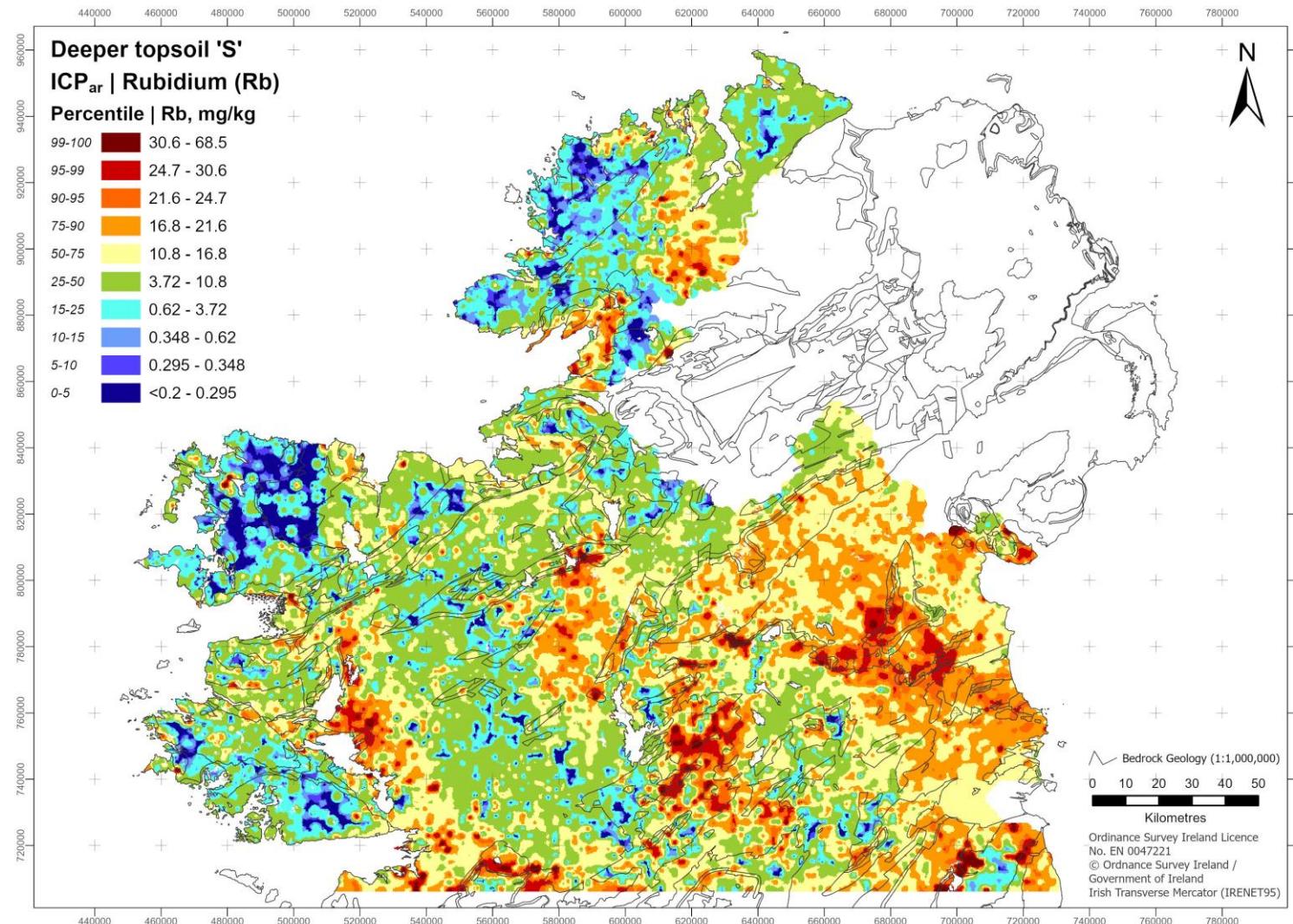


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2.31. Lead (Pb)

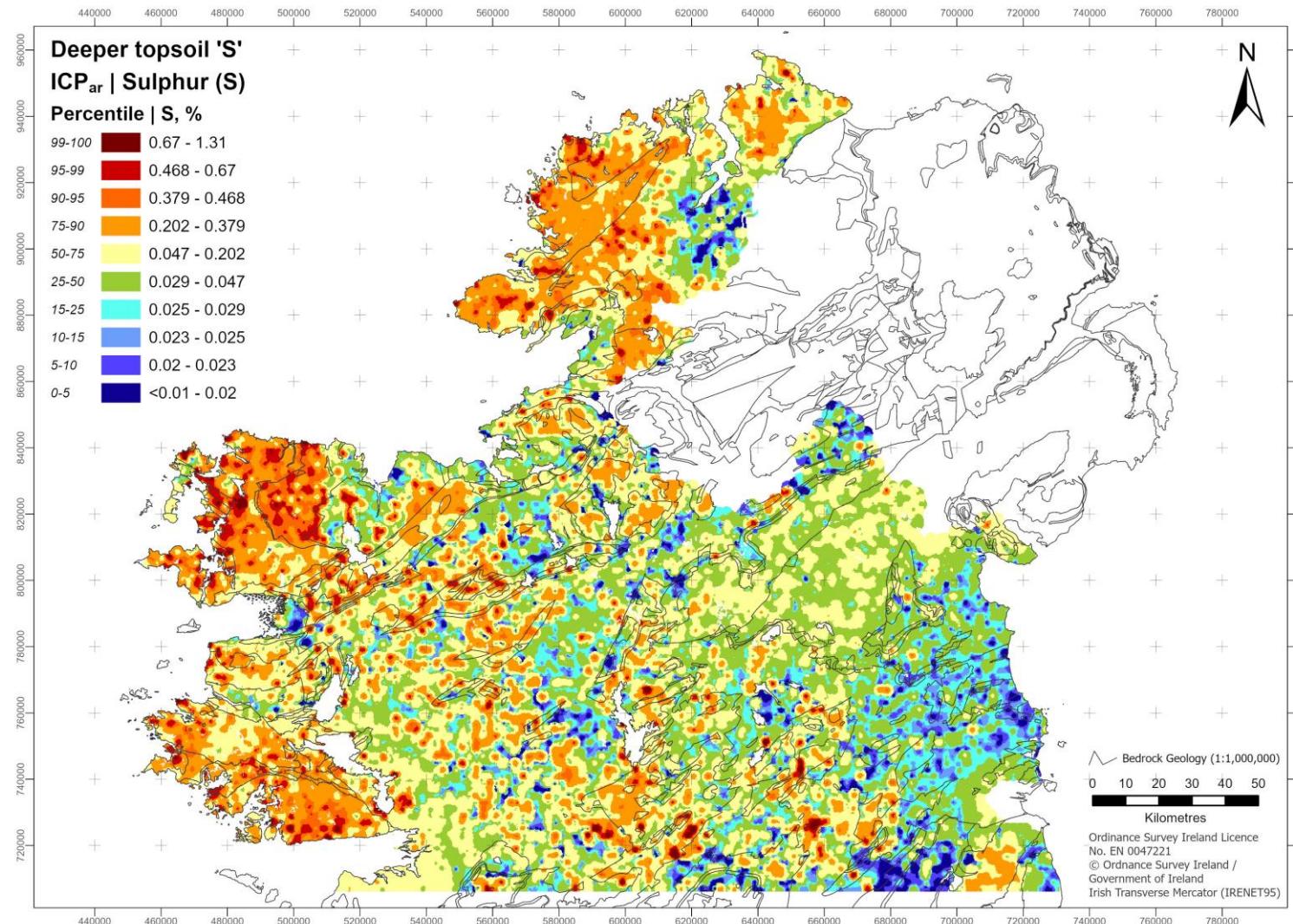


2.32. Rubidium (Rb)

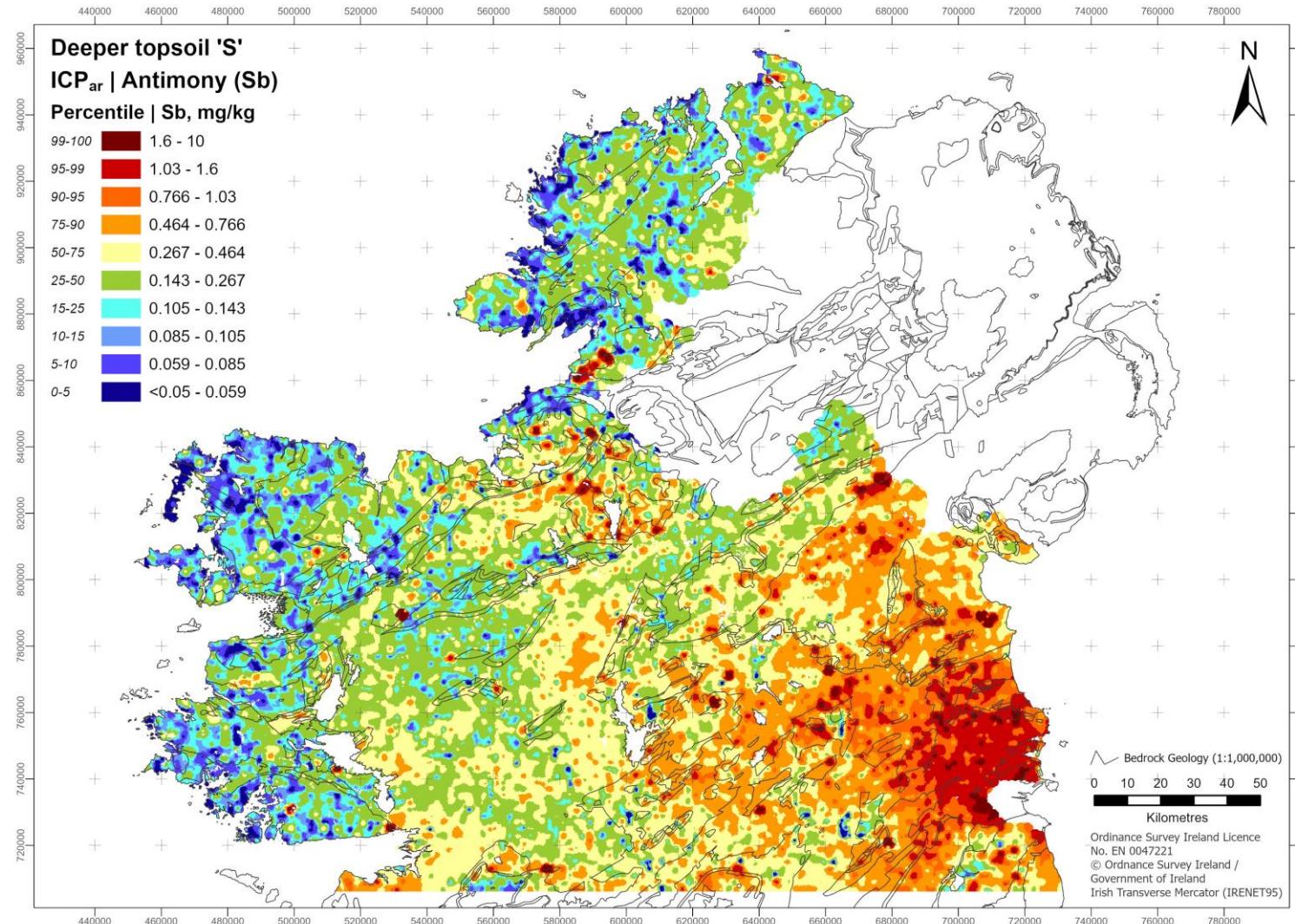


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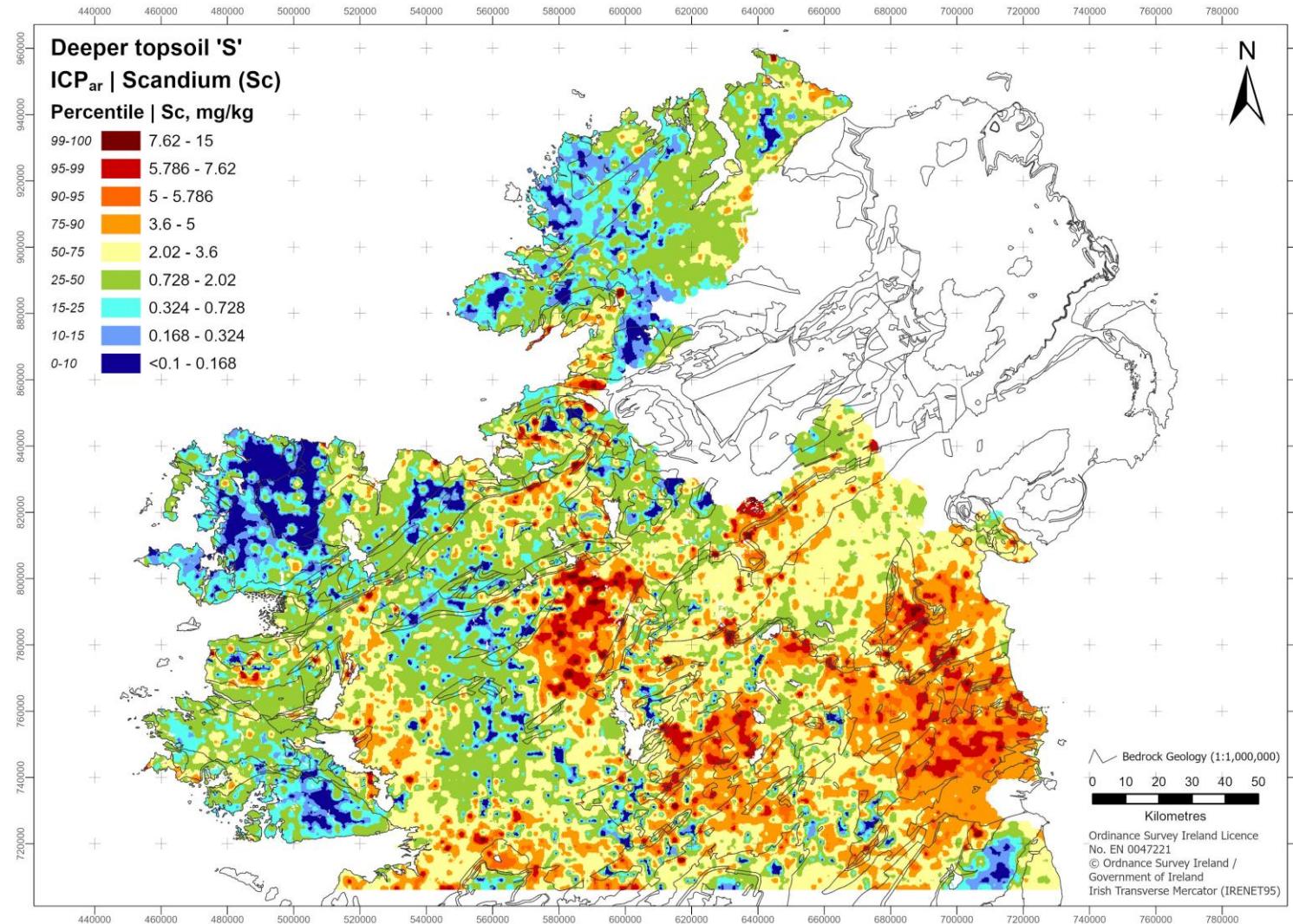
2.33. Sulphur (S)



2.34. Antimony (Sb)

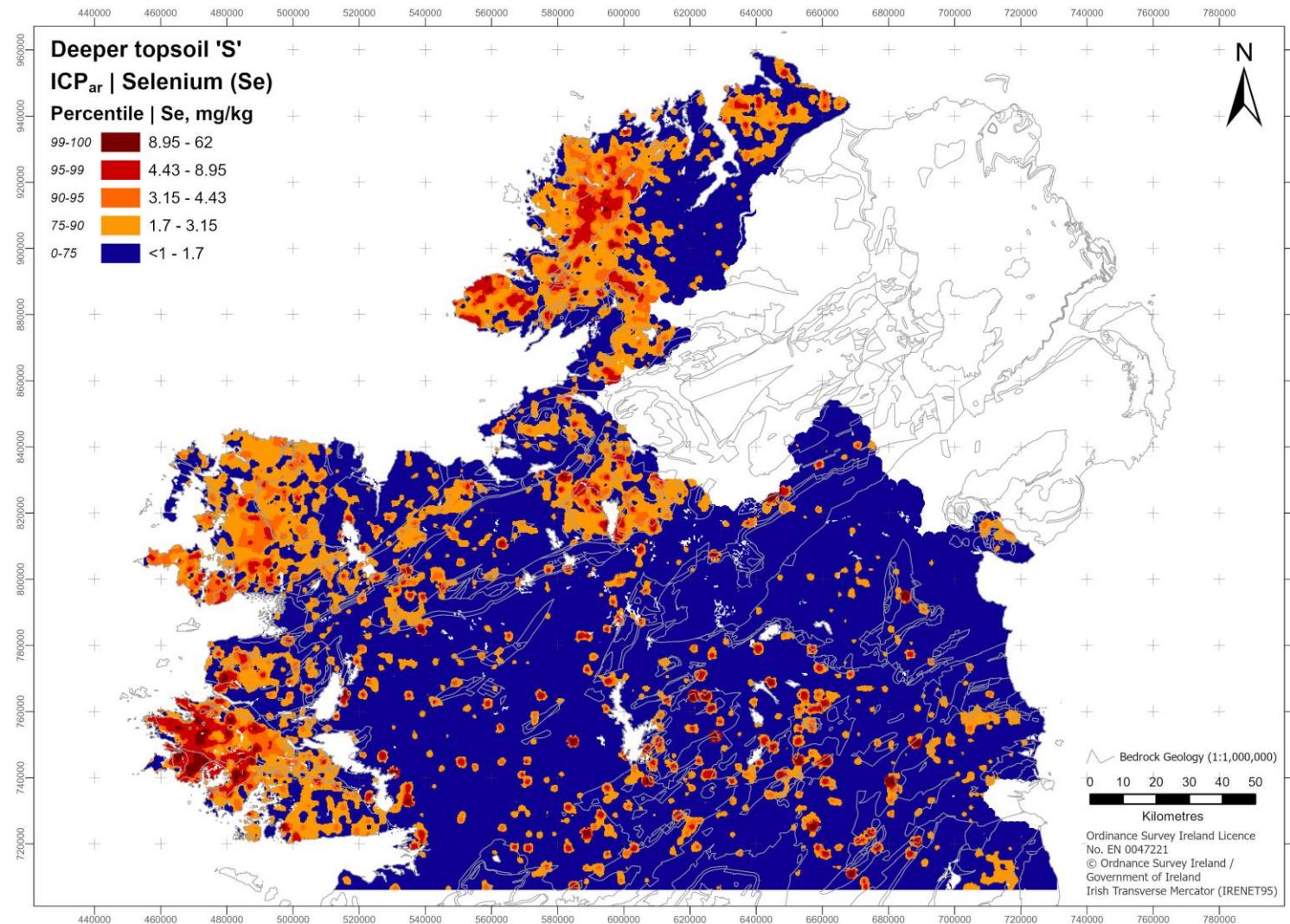


2.35. Scandium (Sc)

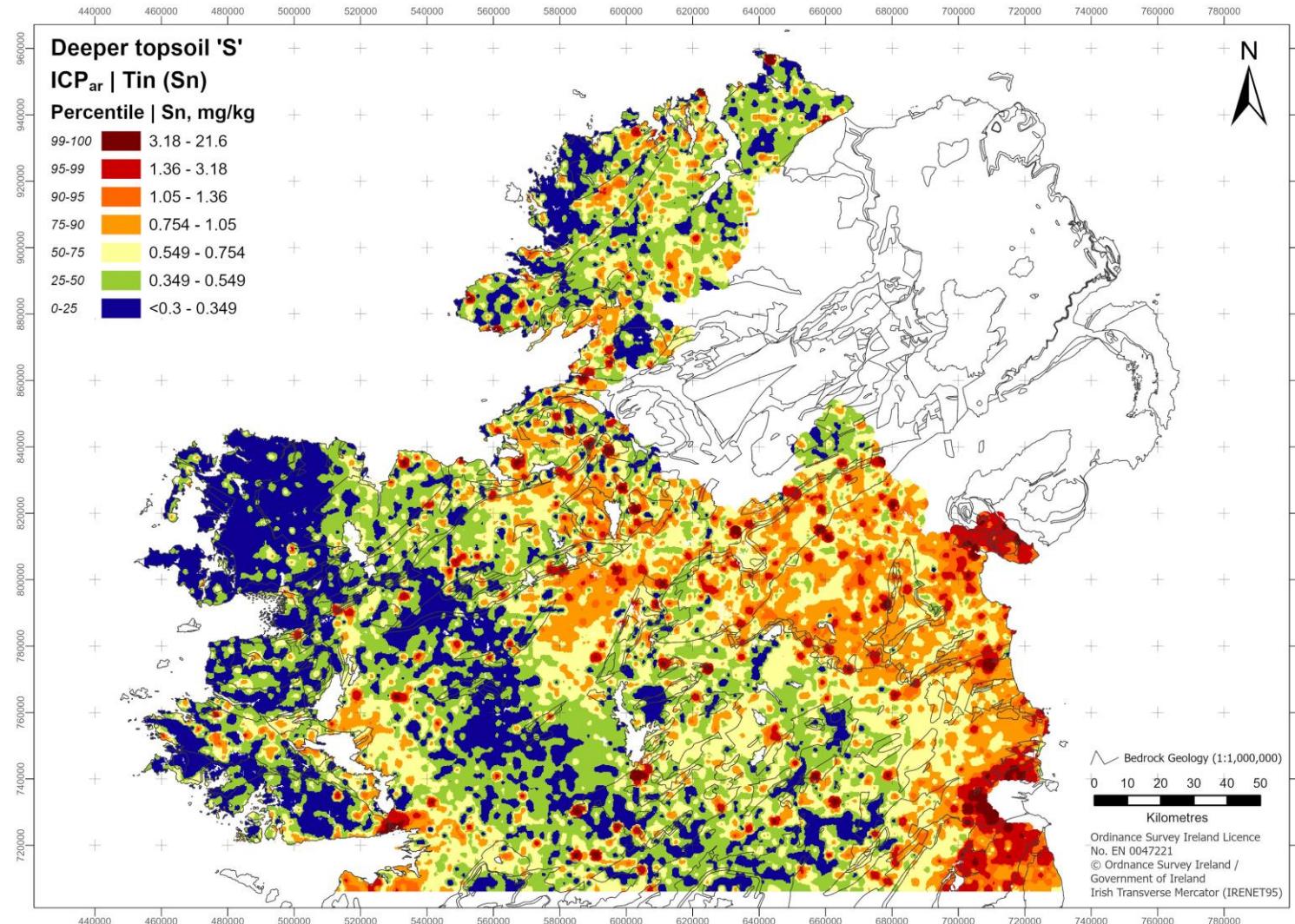


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2.36. Selenium (Se)

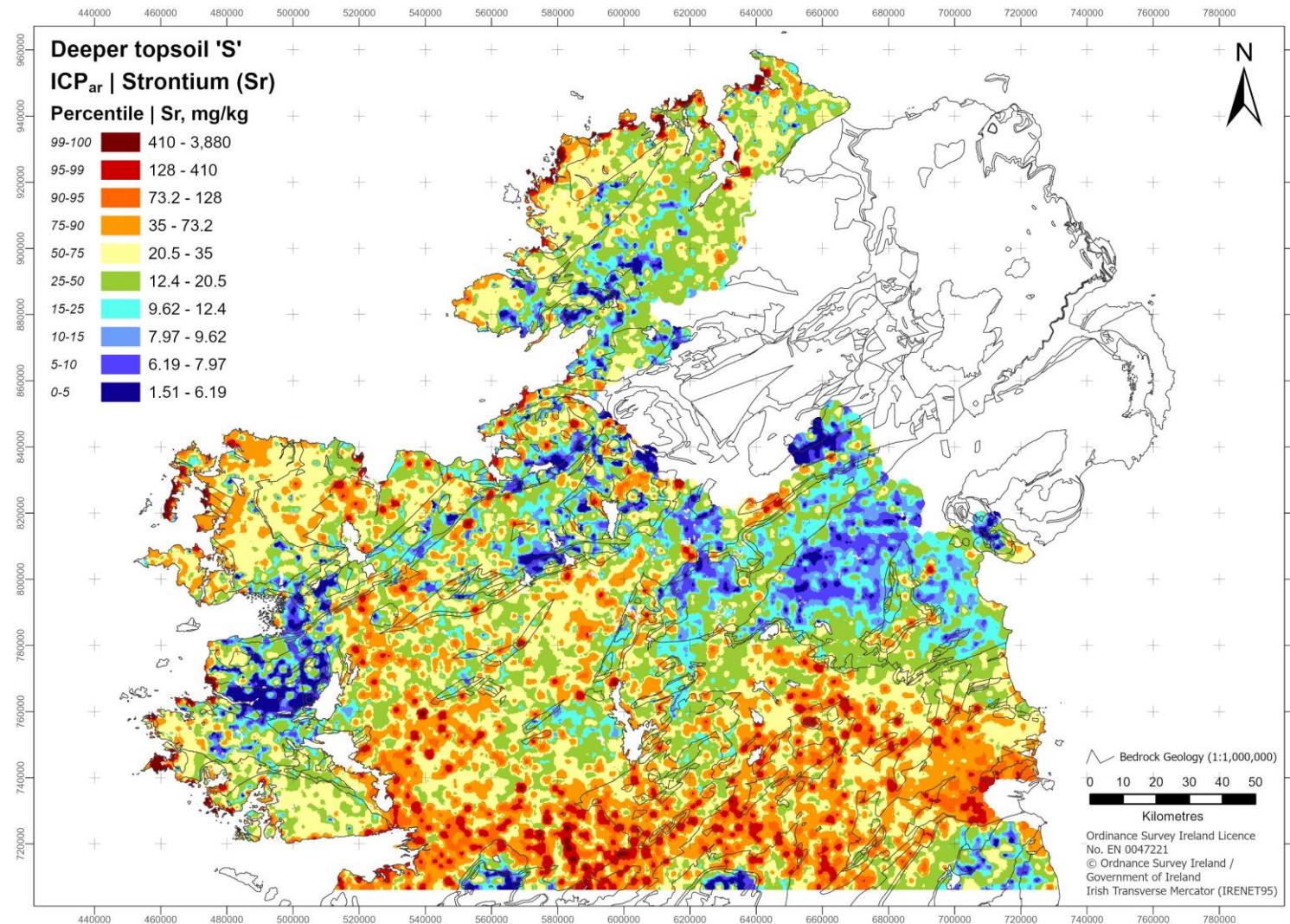


2.37. Tin (Sn)



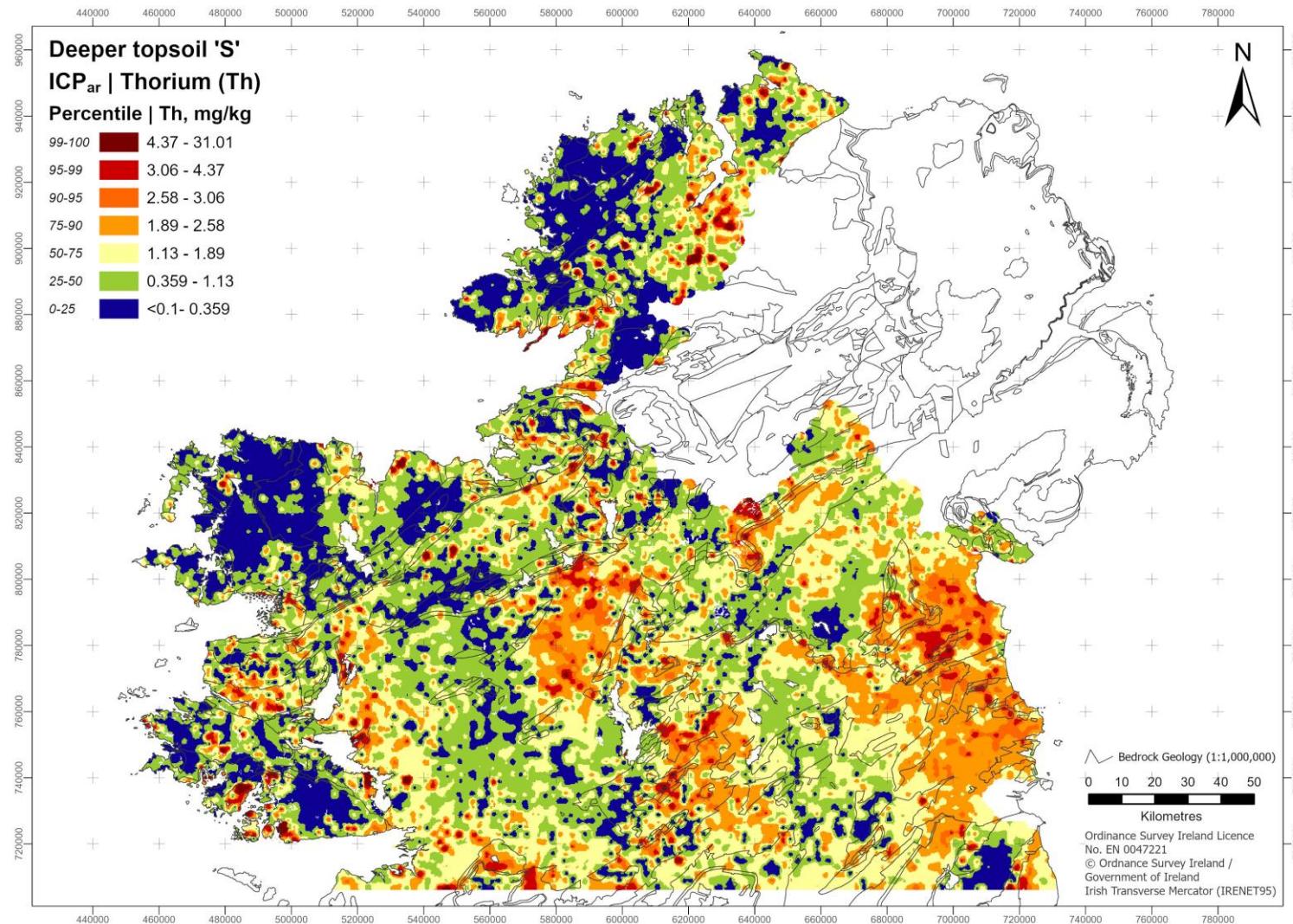
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2.38. Strontium (Sr)

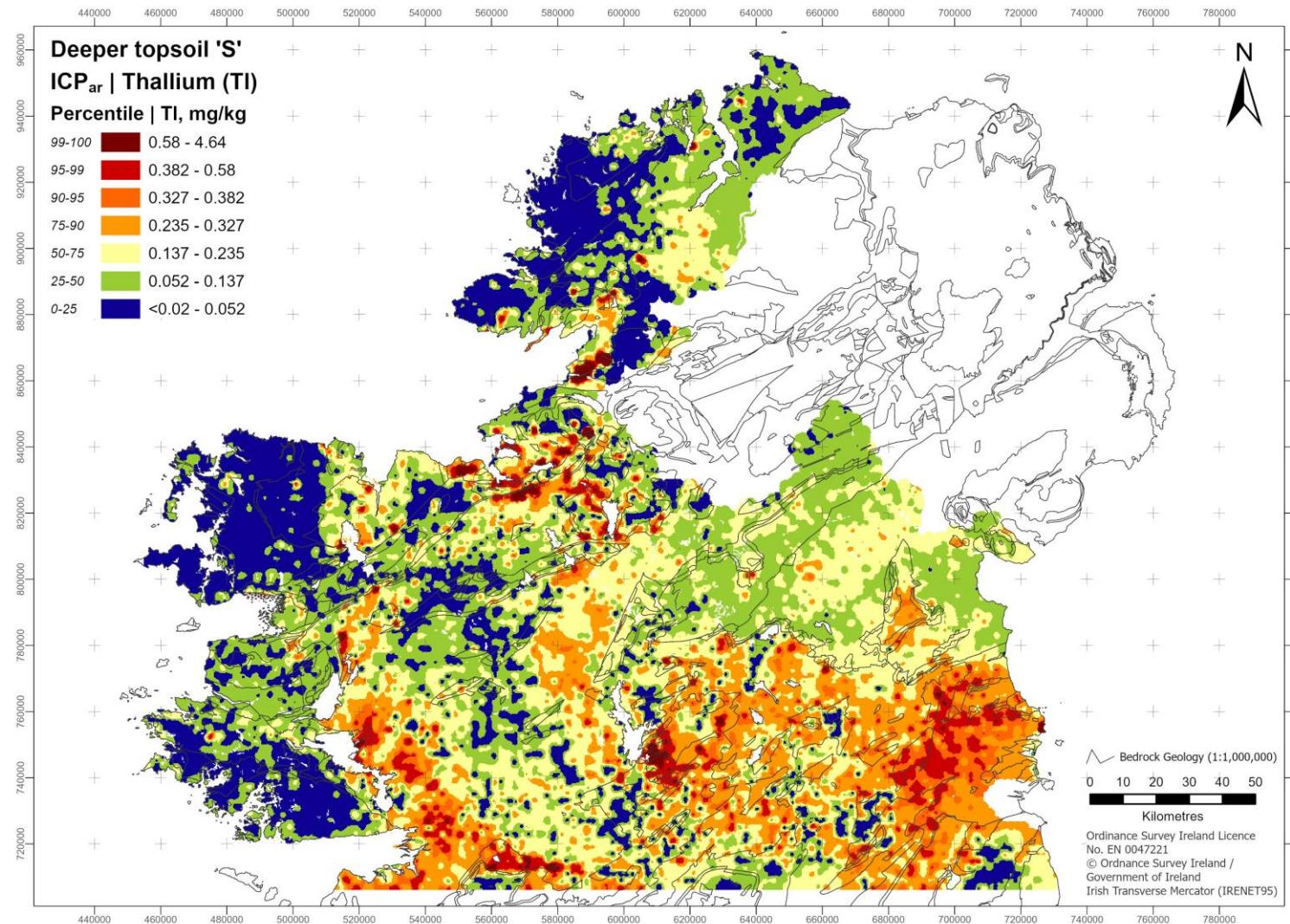


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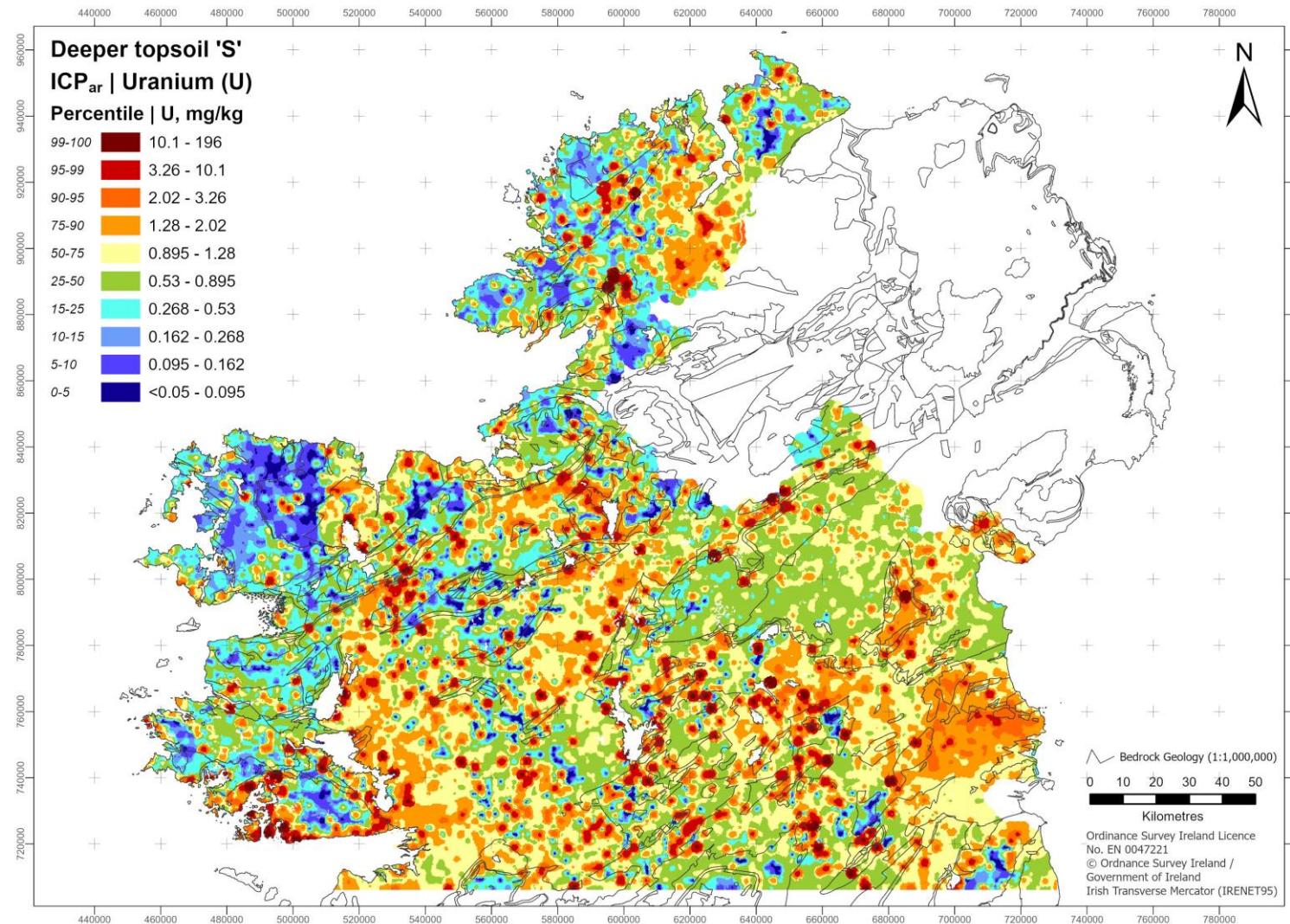
2.39. Thorium (Th)



2.40. Thallium (Tl)

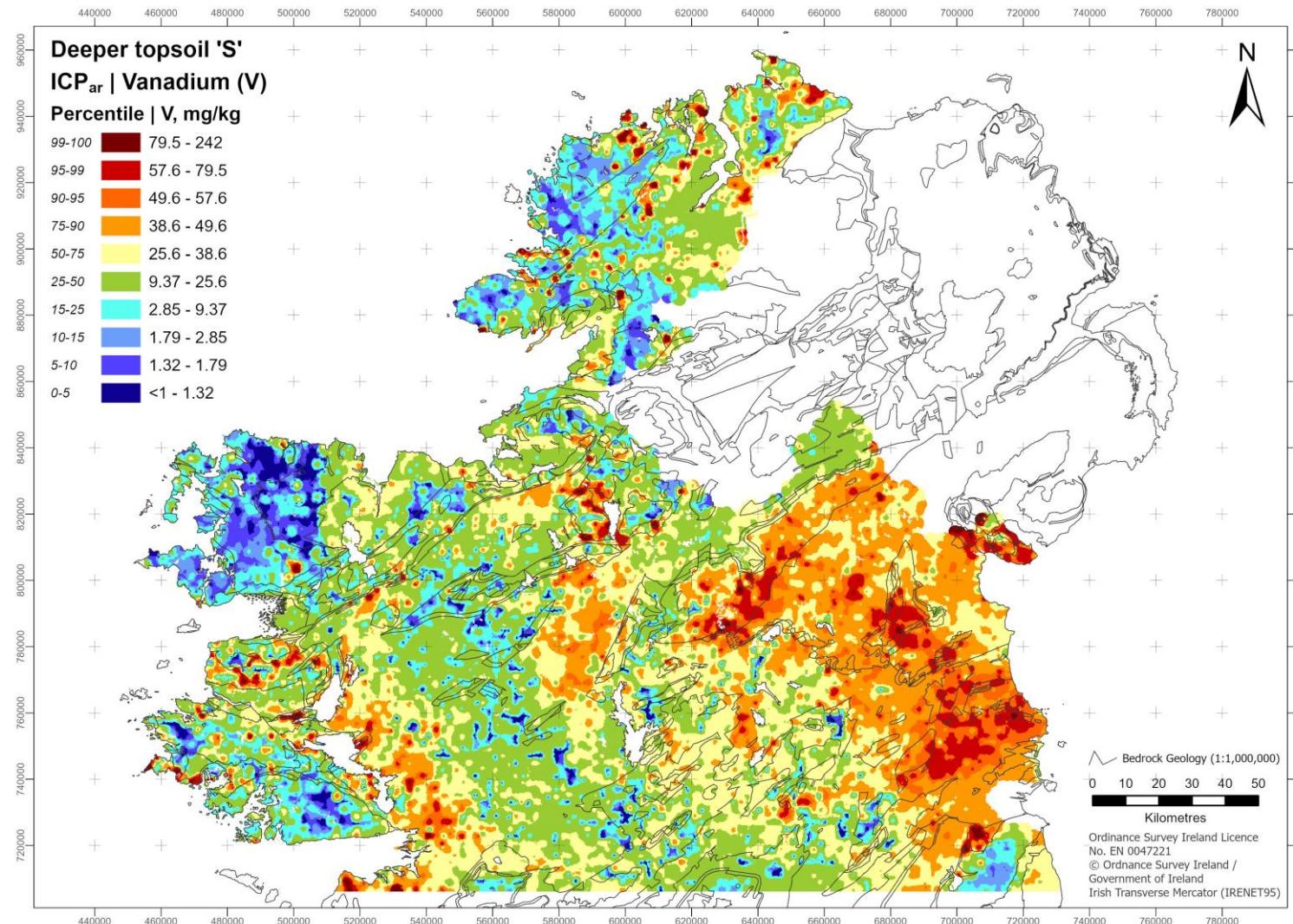


2.41. Uranium (U)



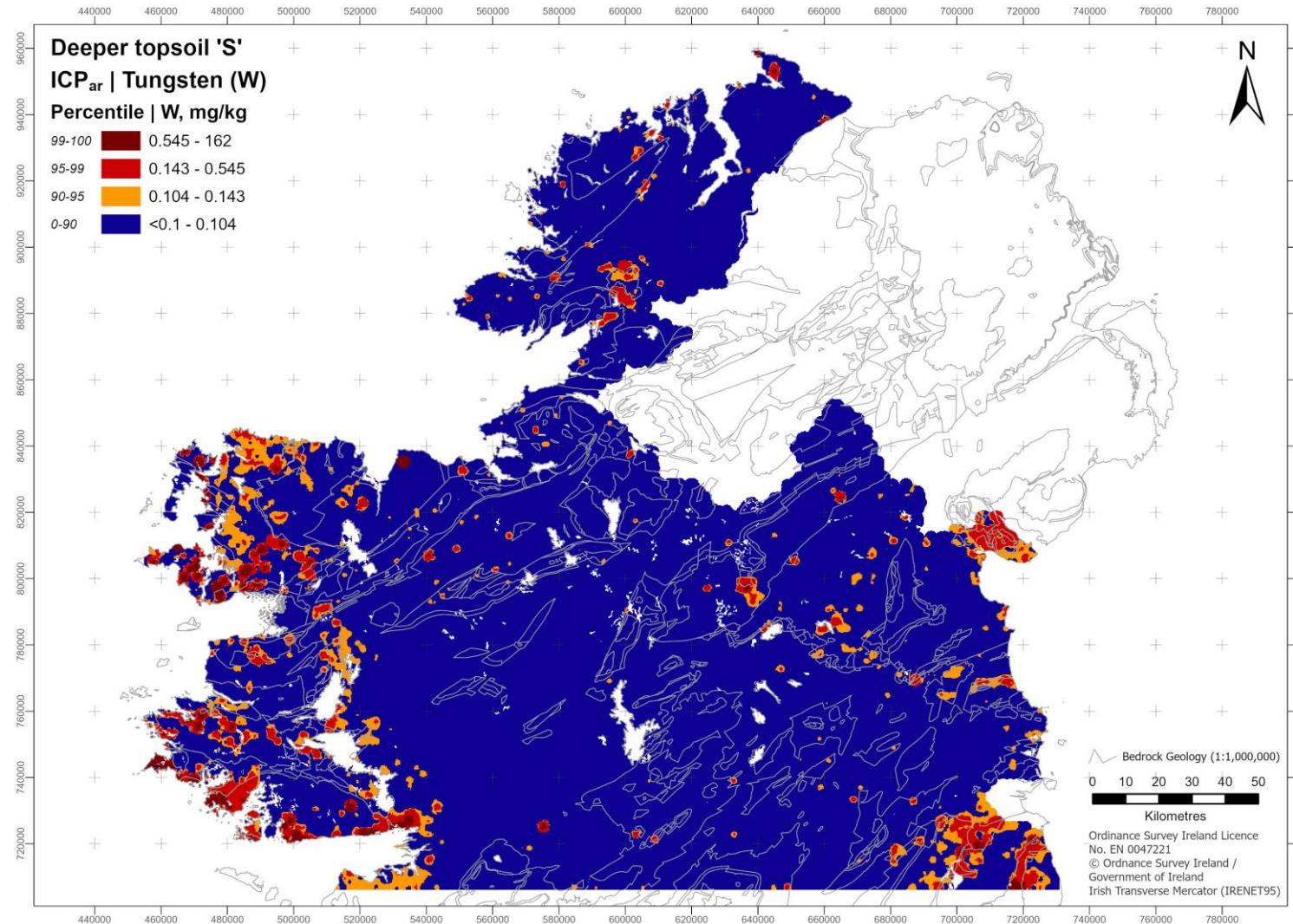
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2.42. Vanadium (V)

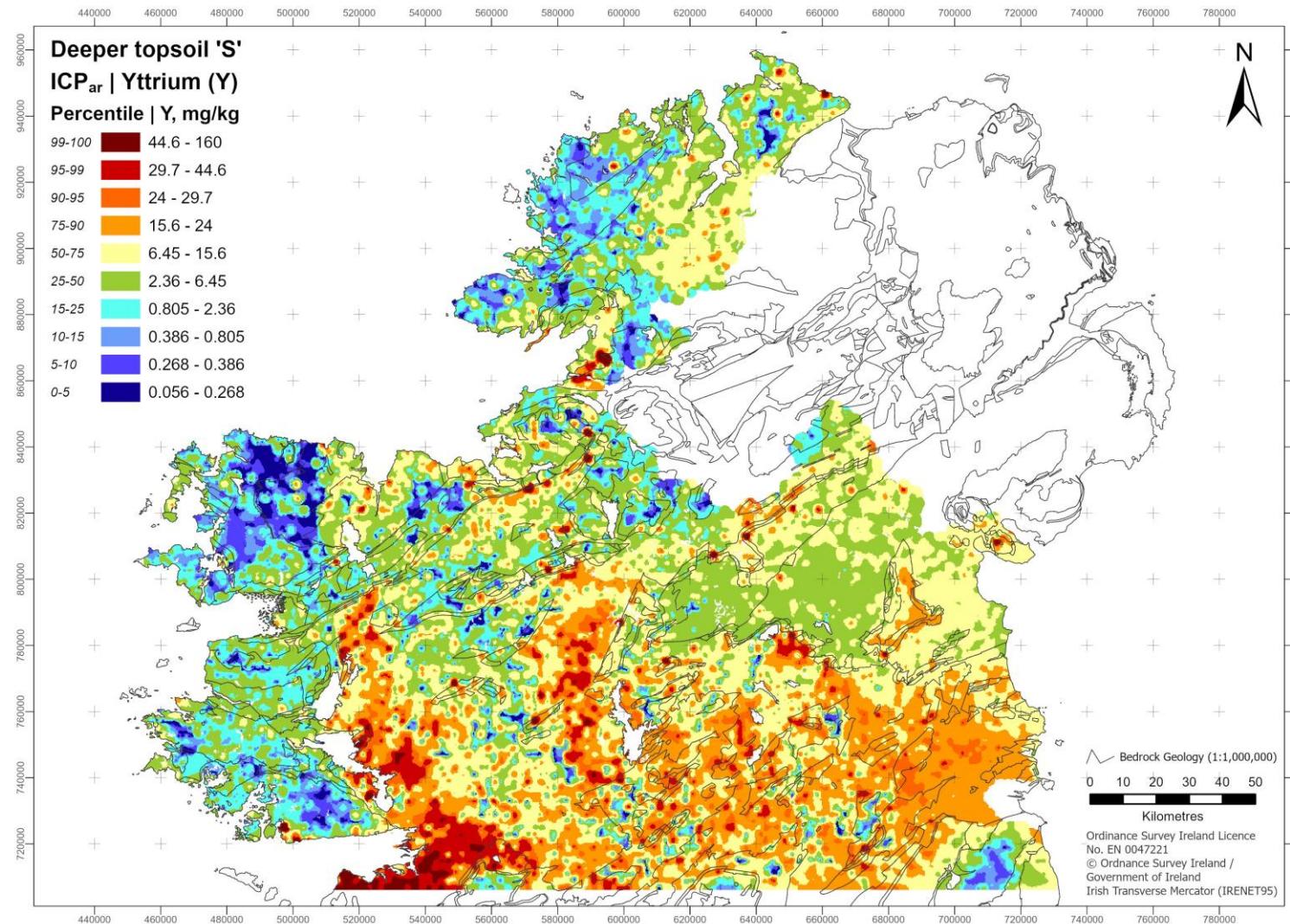


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2.43. Tungsten (W)

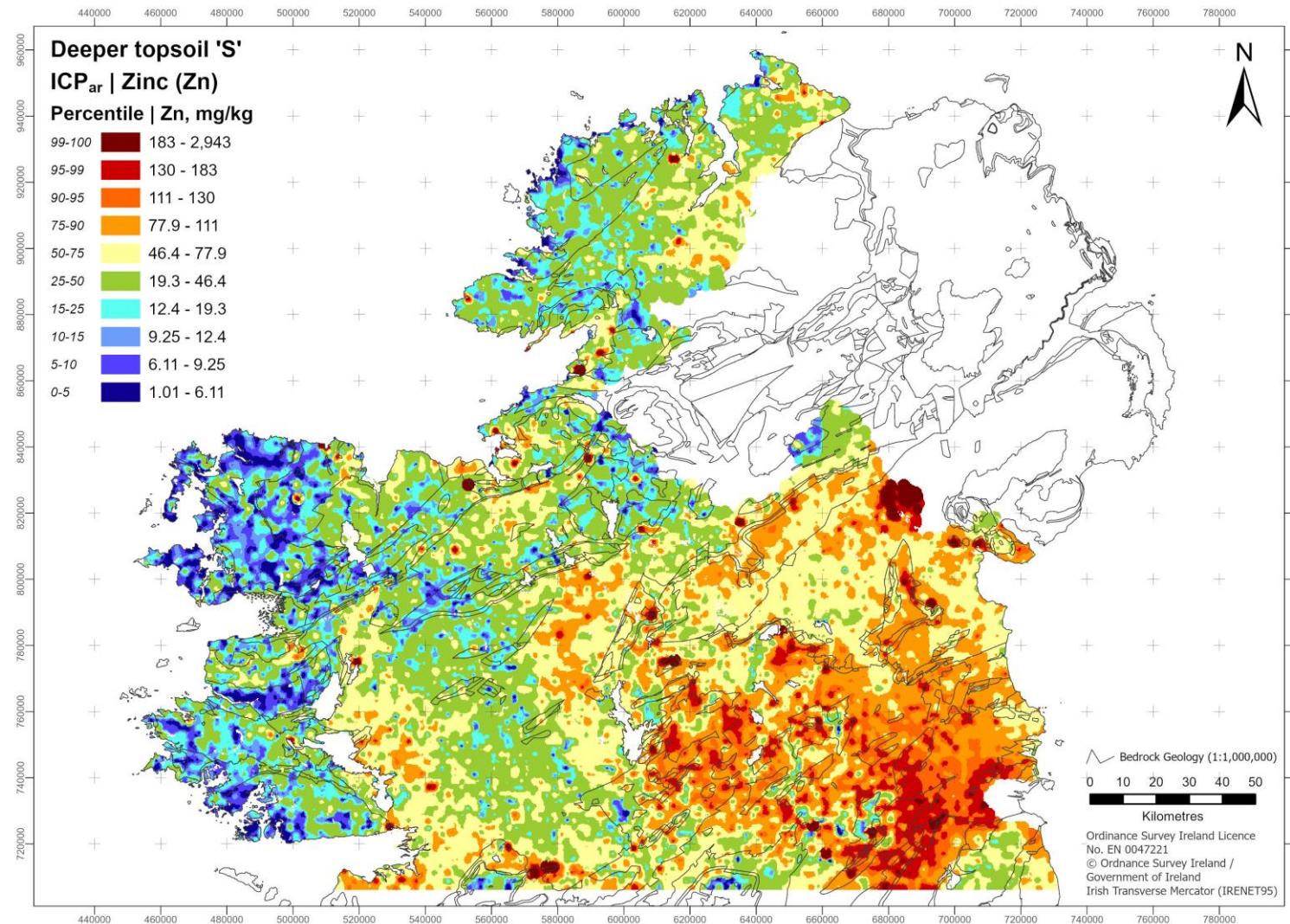


2.44. Yttrium (Y)

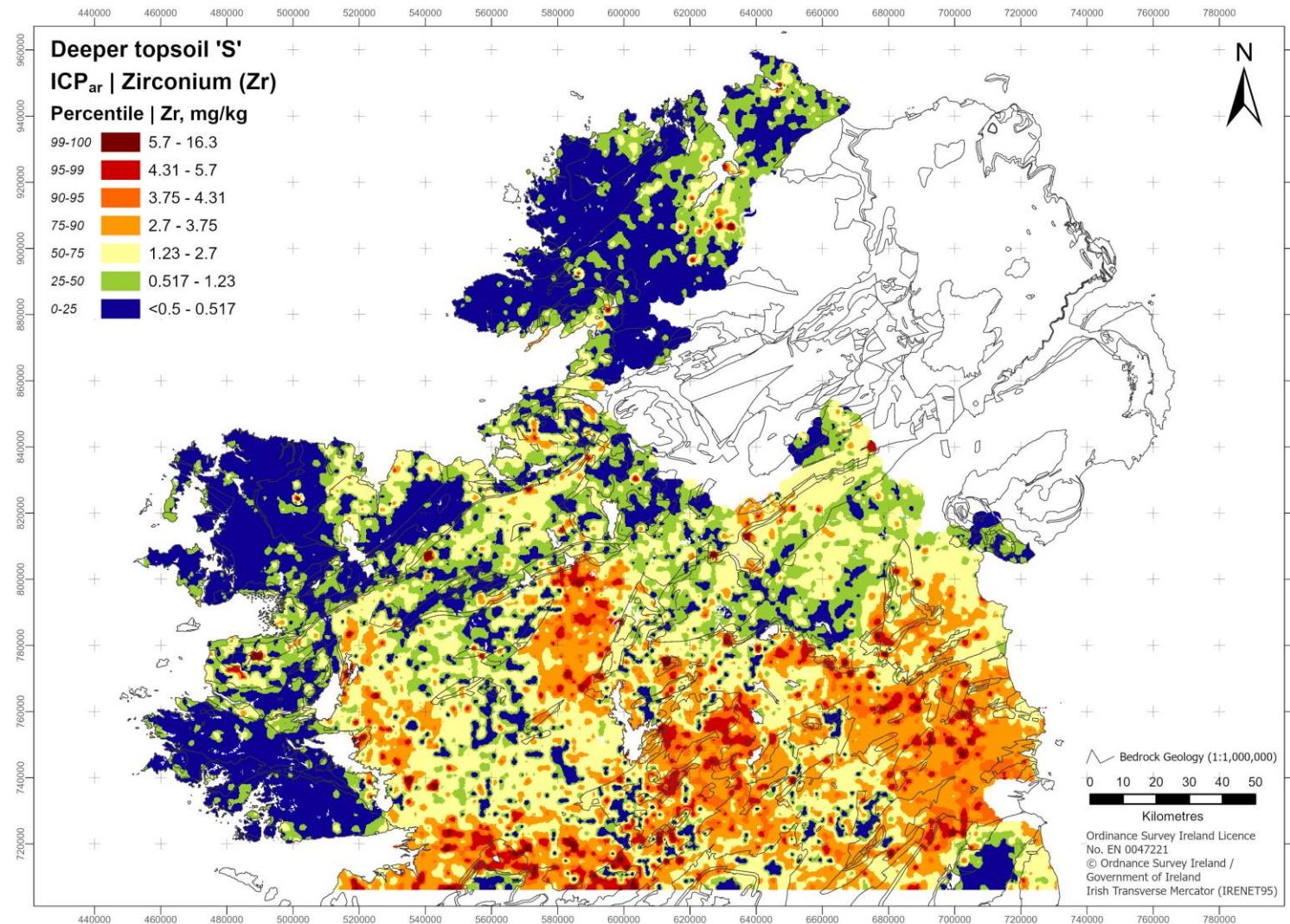


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2.45. Zinc (Zn)



2.46. Zirconium (Zr)



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