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UKI-Array: Opportunities and Applications

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THE UKI-ARRAY: OPPORTUNITIES AND APPLICATIONS

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This paper outlines the scientific opportunities enabled by a proposed dense geophysical sensor network spanning the UK and Ireland, the UKI-Array. Building on a companion paper that introduced the array design, here we describe its applications, including high-resolution imaging of the crust and mantle, monitoring seismic hazards and induced seismicity, and studying near-surface processes such as flooding, landslides and environmental change. The array would also improve the assessment of geothermal energy, mineral resources and subsurface storage potential (including for CO_2 sequestration), while enabling new digital resources such as a national open 3D subsurface atlas to be created. Additional components, such as offshore sensors and infrasound instruments, would extend coverage and scientific applications. UKI-array offers significant benefits for public engagement and education. And it will address declining enrolment in geophysics degrees by bringing awareness of the subject into schools and communities through instrumentation, data and subsurface models. Overall, we propose UKI-Array as a collaborative community project, to unify UK and Irish geoscience, deepen relationships with scientists in neighbouring countries, and significantly advance both scientific understanding and applications of geophysics for societal good.

Introduction

In a companion paper (Curtis et al., 2026), we proposed and motivated a conceptual model for a geophysical array spanning the UK and Ireland (denoted *UKI-Array*). We catalogued existing equipment available to the British and Irish communities, and presented example array designs comprising combinations of the following components. (1) Approximately constant receiver density across the UK and Ireland (*UKI*) to monitor seismicity and greatly refine subsurface images. (2) Dense sub-arrays that focus on specific targets of interest. (3) A linear array oriented approximately North-South and spanning the length of Great Britain to crosscut and characterise major tectonic boundaries. (4) A longer-term deployment that rectifies the non-uniform density of the permanent broadband network to improve Earth imaging. (5) Seabed sensors to extend the survey offshore. (6) The addition of other geophysical sensor types to offer opportunities across the broader UKI Geophysical community. (7) Coordinated synchronous arrays on opposite coasts of the English Channel and North Sea to extend earthquake monitoring and imaging benefits to collaborative communities of geophysicists in neighbouring countries.

In this second paper, we discuss opportunities that illustrate the possible applications of a UKI-Array. We group these into broad categories: *surface processes and environmental geophysics, imaging the subsurface of UKI and surrounding seas, monitoring seismicity and seismic hazard, improving the assessment of subsurface Earth resources and storage sites, and public outreach and engagement*. Many applications are complementary - for example, an array designed for subsurface lithospheric imaging is also likely to improve seismicity characterisation, and any application could be used to generate public interest and engagement. The opportunities described herein were suggested by the UK and Irish geophysical community together with international contributors, at a Royal Astronomical Society Discussion Meeting in 2025; many other potential applications are left for future discussion.

Surface Processes and Environmental Geophysics

Seismological and other geophysical data are frequently used to investigate very near-surface properties and processes in the Earth, including landslides, dam or bank bursts, environmental pollution and a variety of other important phenomena. A few have been proposed as particular potential foci for the UKI-Array.

Fluvial Seismology

Flooding is an increasingly regular, impactful natural hazard affecting the UK and Ireland, with historical floods affecting much of the UK (Wheater 2006). However, with global warming, the multiplication of large storms in the North Atlantic triggers more frequent large flooding events, potentially costing billions of pounds yearly (Reynard et al 2017; Bell et al. 2016).

Despite real-time hydrological monitoring, the only near-real-time information generally available is the gauge height and the overall level of flood risk (https://check-for-flooding.service.gov.uk). To better quantify the potential damage associated with a flooding event, additional information, such as flow velocity and bedload transport, is necessary. Recent developments in fluvial seismology (Cooks and Dietze, 2022) show the potential of using seismological tools to complement hydrological measurements

in monitoring these processes. The analysis of seismic 'noise' from rivers provides information on the evolution and nature of flow regimes, as well as the temporal and spatial evolution of bedload transport during flood events (Matthews et al., 2024). UKI-Array will provide an opportunity to deploy dense networks around rivers to monitor fluvial processes, potentially with a focus on areas in central England that were strongly impacted by recent large flood events, and areas with high run-off and flow rates in Cumbria, Scotland and Ireland. This would provide a unique opportunity to develop data to demonstrate the concept of a new early-warning system for flooding that combines seismological and hydrological data.

Groundwater Aquifers

Groundwater comprises 30% of drinking water in the UK and is under pressure from climate change, and competing demand for aquifers for storage, waste disposal, geothermal energy and mineral extraction. Although well characterised to 200 m, where public water supply occurs (Allen et al 1997) there is little information on the extent and properties of aquifers at depth where much of the new interest is placed. UKI-Array could establish a framework for the geometry and properties of aquifers in the shallowest 2 km, to help deepen understanding of UK aquifers and how they respond to extreme events such as droughts, to contribute to their future development and management.

Monitoring Coal Spills

Coal spoil tips continue to pose a significant hazard to former mining communities across the UK and Ireland, with the 1966 Aberfan disaster representing the most severe mining-related tragedy in the UK. The increasing frequency of wet winters has further exacerbated the likelihood of spoil tip collapse or landslides (Figure 1). As of 2024, there are 2,573 spoil tips in South Wales (approximately 40% of the UK total), of which 350 have been designated as presenting a 'high risk' to public safety (https://www.gov.wales/coal-tip-safety). At present, these high-risk sites are subject to annual or biannual inspections, rather than continuous monitoring. To extend and complement existing inspection regimes, UKI-Array could establish an initial baseline monitoring framework for long-term, continuous surveying of coal tips by assessing spatial and temporal variations in seismic wave properties (e.g., seismic velocities or attenuation). These are sensitive to changes in subsurface conditions, including fractures and other areas of weakness. Seismic recordings would also enable the detection and localisation of slip events associated with ground movement and structural failure (Le Breton et al., 2021).

Landslides

Landslides represent a genuine and growing hazard across UKI, threatening infrastructure, coastal properties, and communities. The majority are triggered by rainfall. Seismology offers several practical methods for understanding and reducing this risk (Whiteley et al., 2019). Seismic methods such as the horizontal to vertical spectral ratio (HVSR) technique (Nakamura, 1989, 2019; described below) can help to estimate the volume of material susceptible to remobilisation, while a seismic array could provide early warning and detection by capturing ground motion generated during a landslide event or by

identifying precursory slope creep ahead of failure. The latter can be through either seismic event detection, cross-correlation of ambient noise, or recovering tilt measurements from seismic signals (e.g., Watlet et al., 2025). There is also potential to characterise landslide signals by their seismic properties — such as the recorded frequency content — to determine the type and scale of movement remotely, without the need for the site to be attended (e.g., Rekapalli et al., 2024).



***Figure 1**: Image of landslide associated with a coal spill at Tylorstown in Rhondda Cynon Taf, South Wales on 16 February 2020. Image from https://blogs.agu.org/landslideblog/2020/02/17/tylorstown-landslide/*

Imaging the Subsurface of the UK, Ireland and Neighbouring Seas

The subsurface of the UK and Ireland has been imaged using the existing permanent seismic network and numerous temporary stations, some of which have operated for up to 10 years. Studies using teleseismic earthquakes (e.g., Bonadio et al. 2025, Arrowsmith et al 2005), fundamental mode surface waves (e.g., Nicolson et al., 2014; Galetti et al., 2017), and local earthquakes (Luckett and Baptie 2015) have provided insights into large-scale subsurface structures such as geological terrane boundaries and lithospheric thickness variations, and provide clues to dynamic processes that cause earthquakes and observed ground motion. UKI-array's higher spatial density would offer finer-scale imaging resolution, hugely improving existing images and refining geodynamic hypotheses.

A 3D Atlas of the UK and Ireland

An overarching focus and deliverable of the UKI-Array project would be a scalable 3D atlas of the uppermost few hundred kilometres beneath the UK and Ireland and surrounding seas. All locations in the atlas would be populated with best-estimate Earth properties and uncertainty or range estimates *a priori*, and refined over time using UKI-Array and any other available data. An explicit 3D atlas would be

hosted online, freely available to the public and stakeholders, and would be collaborative, allowing results for each facet of the UKI-Array to be integrated and updated by the joint academic, geological survey, and industrial community. Information in the atlas could comprise layer boundary positions, densities, seismic velocities, anisotropy, attenuation, temperature, geothermal gradient, electrical conductivity and magnetic susceptibility – each geo-referenced to within the subsurface. Ideally, it would interface with existing online geological maps of the UK and Ireland.

Compiling this atlas with data from existing studies before the deployment of UKI-Array will address key gaps in priority regions, such as areas prospective for minerals and/or geothermal energy and areas of higher hazard. The atlas should be adaptable and interactive, allowing a scientist to extract mantle transition zone properties across the whole of the UK and Ireland, a landslide hazard expert to download depth-to-basement information when planning a new road, a minerals exploration company to obtain depth-to-Moho estimates for their exploration models, and school pupils to become inspired by the Earth beneath their feet. The creation of such an atlas encapsulates the spirit of joint endeavour in the project, and its purpose would reflect that of the UKI-Array community: scientific discovery, unlocking the resources beneath our feet, and enabling geoscientists to work together to solve UK, Irish and global issues.

Depth to Bedrock

The depth necessary to drill or dig before encountering solid bedrock is a critical quantity for most, if not all, civil engineering projects. In sedimentary basins, the transition from sediment to bedrock is usually marked by a large impedance contrast representing a significant shear-wave velocity increase. Yet bedrock depth is not well known in some areas across the UK, nor offshore, because spatially detailed seismic velocity data is not available across extensive regions of the UK.

With 3-component sensors installed in the UKI-Array, bedrock depth can be characterised using an automated HVSR analysis of the ambient seismic noise (Nakamura, 1989, 2019; Ibs-von Seht and Wohlenberg, 1999). HVSR analysis can map sedimentary infill of larger basins, such as the London or Midland Valley basins. To convert the HVSR to depth, we require knowledge of the shear-wave velocity of the sedimentary infill. A practical approach relies on installing three-component nodes, or seismometers, above boreholes for which the depth to the seismic bedrock is known, such as those from the UK Onshore Geophysical Library. Empirically derived relations then allow the HVSR of each sensor to be converted to an approximate depth (Van Noten et al., 2022) for the UKI-Array atlas. To create sedimentary basin cross-profiles, nodal instruments could be deployed in linear arrays through target areas (Van Noten et al., 2024). HVSR results can then be compared with simple receiver-function phase-delay picks for deep basins (e.g., Marignier et al., 2024), and other types of geophysical survey could then be conducted to constrain properties of particular targets of interest.

As the UKI-Array will record data for several months, continuous data streams offer the additional advantage of monitoring HVSR variations over time (see Figure 2), thereby providing insight into water table variations. The ultimate target would be to improve geological models of sedimentary infill and depth to bedrock of large basins, and to generate a UKI HVSR database, following examples from other countries (Anbazhagan et al., 2025). This database would provide critical constraints for microzonation, seismic amplification, site characterisation, and shallow geothermal energy studies.

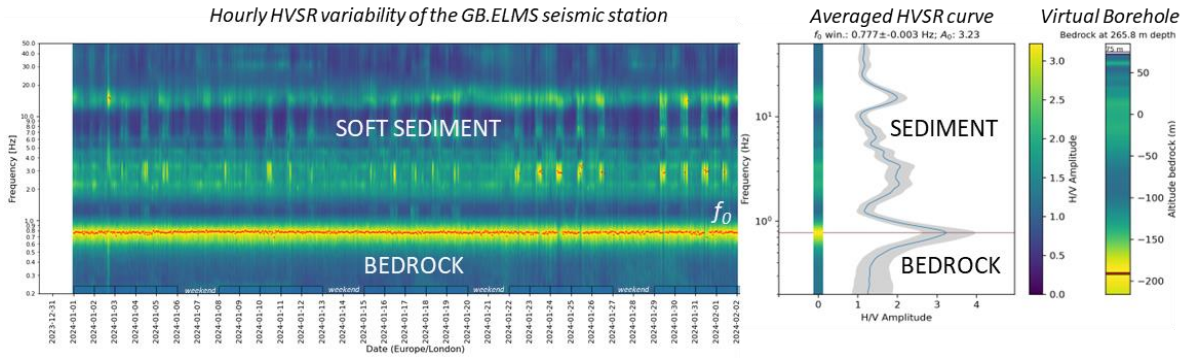

Figure 2: *Left: HVSR data analysis of one month of data of the GB.ELMS station in Suffolk, UK. The continuous red line shows a stable resonance frequency (f_0) of 0.777 Hz. Right: The one-month averaged H/V curve is converted to a Virtual Borehole using the bedrock depth from British Geological Survey borehole TM05NW65, extracted from the UK onshore geophysical library. The entire H/V curve is converted to depth according to the relation h = Vs / (4 f_0) – Roesset (1970).*

Thermal Structure and Thickness of the Lithosphere and Underlying Asthenosphere

The thermal structure and thickness of the lithosphere show substantial long-wavelength variations across UKI (Bonadio et al. 2025). These variations may exert controls on seismicity, seismic hazard (Lebedev et al. 2023), and geothermal energy resource potential (Chambers et al. 2025). Thin lithosphere also correlates with the distribution of Paleogene uplift and magmatism, with lithospheric thinning potentially driven by the transport of the Iceland Plume (Bonadio et al. 2025). Despite their fundamental importance and societal-economic relevance, maps of lithospheric thickness, temperature, and strength remain incomplete due to gaps in station coverage, particularly in Scotland, SE England, and offshore. Filling these gaps will improve our understanding of the tectonic and geodynamic evolution of UKI, the generation and distribution of the geothermal energy and mineral resources, and the mechanisms that control the distributions of seismicity, the thickness of the seismogenic layer, and seismic hazard.

Deploying 10 to 20 new broadband stations in existing coverage gaps will better sample the subsurface of Britain and Ireland (Figure 3), enabling higher-resolution imaging of the lithosphere's thermal structure and thickness, and mantle temperature. Phase-velocity curves for Rayleigh and Love surface waves could then be measured and inverted directly for temperature through thermodynamic relations. This would reduce seismic tomographic non-uniqueness (under the thermodynamic assumptions), yielding physical models of the crust and upper mantle that fit seismological data, and feature realistic geotherms (e.g., Lebedev et al. 2024). Joint inversion of receiver functions and constraints imposed by other interfaces (e.g., the Moho) would provide complementary evidence.

A particularly interesting target has been identified in magnetotelluric images (Montiel-Álvarez et al., 2025): a prominent electrical conductor beneath the Anglo-Welsh border at depths of approximately 85-140 km (Figure 4), which may be associated with fluids and melt. Joint inversion and integrated interpretation of seismic surface waves and long-period magnetotelluric data offer a promising route to investigate the fundamental properties of the anomaly and its relationship to the tectonic history of the

UK and Ireland. A deployment of broadband seismic stations around the area, to maximise the number of crossing raypaths through the conductive structure, would allow its seismic velocity and attenuation structure to be constrained from the surface down to ~200 km depth. Integration with existing datasets (e.g., Bonadio et al., 2021) would also enhance both data coverage and multi-physics interpretation across the entire UK and Ireland.

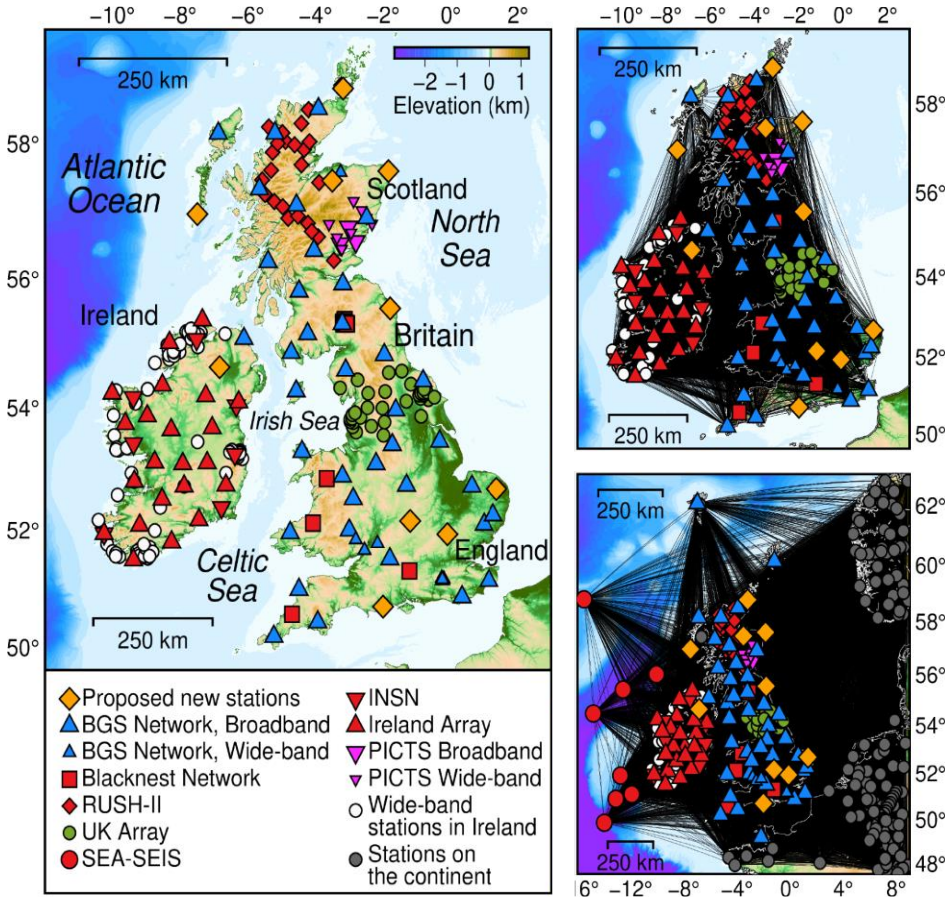

Figure 3. *Example locations of 10 new broadband stations that would fill gaps in the existing broadband-station coverage. More uniform coverage (right panels) would be achieved by the proposed new stations (left panel, orange diamonds), spanning the UK and Ireland. By including existing international stations the surrounding seas will also be sampled (lower-right).*

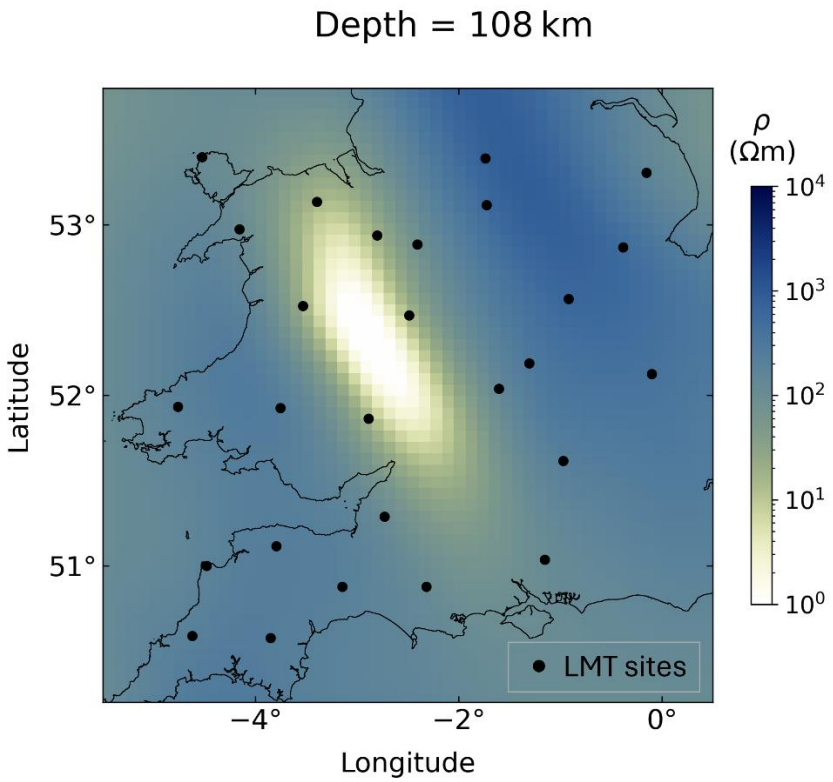

Figure 4: *Horizontal slice of the 3D electrical resistivity model of the UK (Montiel-Álvarez et al., 2025) showing the West Midlands Conductor at 108 km depth. Black dots indicate the locations of current long-period magnetotelluric sites.*

Imaging of Faults and Tectonic Structures

The UK is divided into distinct terrains, each bounded by large crustal-scale fault zones or sutures that are generally oriented NE-SW. Currently, there are limited exposures of these features, leading to a poor understanding of the origin and architecture of crustal faults, from the fault cores to their wider damage zone (Figure 5). The trans-UK linear array design (see Figure 3 in the companion paper, Curtis et al., 2026) is designed to intersect these faults, allowing their subsurface structure and properties to be probed.

The location and tectonic significance of many proposed suture zones are still debated, so the detailed tectonic history of the UK is somewhat speculative. For example, surface geology datasets indicate the presence of the Ynys Môn Line as a Devonian suture across the Irish Sea and South Pennines, turning northwards towards Shetland (Waldron et al. 2025; Gemmell et al., 2025; MacRae et al., in press; Bullen et al., in press). Together, these interpretations contribute to ongoing debates about the geometry and polarity of subduction during closure of the Iapetus Ocean in the Caledonian Orogeny (Lamont et al., 2025). Existing geological models of the UK and Ireland must therefore be tested geophysically, as they have the potential to rewrite our understanding of the distribution of structures, economic resources and geothermal prospects.

Damage zones within crustal-scale faults are complex regions of brittle and ductile deformation, hydrothermal alteration, and igneous processes, and can be several kilometres wide (Figure 5). Understanding the geological properties of crustal faults is crucial for de-risking major renewable

engineering projects and understanding fluid flow processes for energy storage. One major fault of particular geological and cultural significance is the ~2 km wide Great Glen Fault Zone (GGFZ), which separates the Grampian Mountains and NW Highlands (Figure 6). The GGFZ has a long and complex tectonic history, having formed during the Caledonian Orogeny in the Devonian and subsequently undergoing multiple phases of reactivation. The GGFZ shows a range of processes, including high-grade ductile deformation, reaction softening (Stewart et al., 1999), hydrothermal alteration, and intrusions. Structures within the damage zone act as pathways for deep-crustal fluids, resulting in metasomatism (Garson et al., 1984). While the subsurface extent of the anomalous structure of the GGFZ has recently been observed to around 9 km depth using large-scale passive seismology (Zhao et al., 2026), more focused UKI-Array data could be used to image zones of weaker versus harder fault rock, thereby developing a new understanding of the nature of the wider GGFZ. Passive seismic and broadband magnetotelluric profiles would allow imaging of density, electrical conductivity, and permeability contrasts across the fault core and damage zone (Figure 6), thereby giving *a priori* information for characterising other major faults across the UK and Ireland.

In East England and the Southern North Sea (SNS), a well-preserved fossil subduction system, imaged by legacy deep seismic reflection lines (Klemperer & Hobbs, 1989), is believed to record the Ordovician subduction of the Tornquist Sea, which separated Avalonia from Baltica (Pharaoh et al., 1993). In the SNS, at least two orogenic sutures are present, bounding crust of uncertain affinity: the Thor Suture, nearer Baltica, and the Dowsing Suture, off The Wash (Figure 7). The calc-alkaline Lake District-Wash-Brabant magmatic arc was generated by subduction at the latter. The Wash Igneous Complex (WIC) is believed to be the source of preserved tephra from volcanic super-eruptions. A future extension of UKI-Array could acquire seismic refraction data to improve stacking velocities on deep reflection profiles, using 20–30 seabed instruments and a similar number of onshore broadband stations operated in passive and active-source modes using quarry blasts or large marine airguns (Figure 7). This would improve understanding of early Caledonian crustal structure, post-Caledonian extensional reactivation, deep hydrocarbon prospectivity, geothermal and nuclear infrastructure planning.

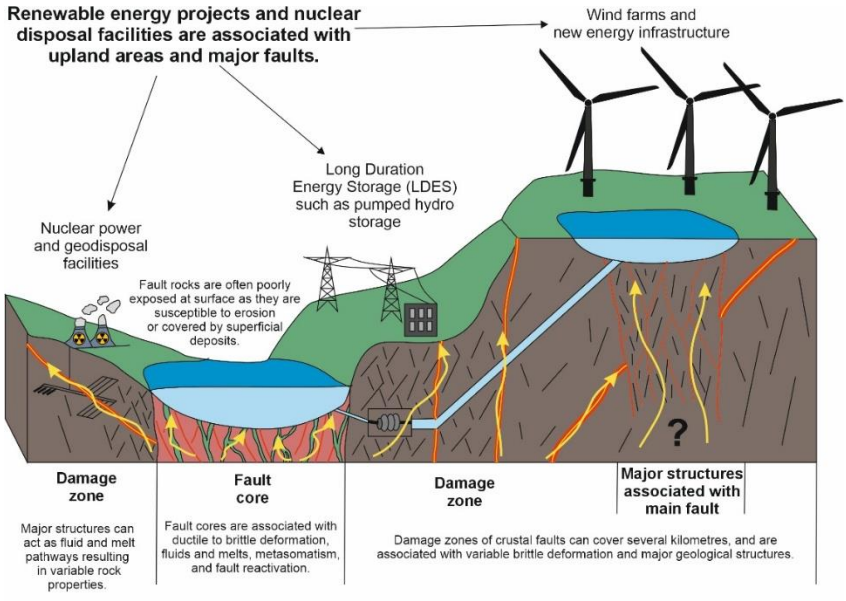

Figure 5*: Schematic model of a crustal-scale fault zone illustrating the diverse processes operating within the fault core and extending into the surrounding damage zone. These processes influence fluid flow and the engineering properties of the shallow subsurface, with important implications for decarbonisation initiatives, including renewable energy developments and potential nuclear waste disposal sites.*

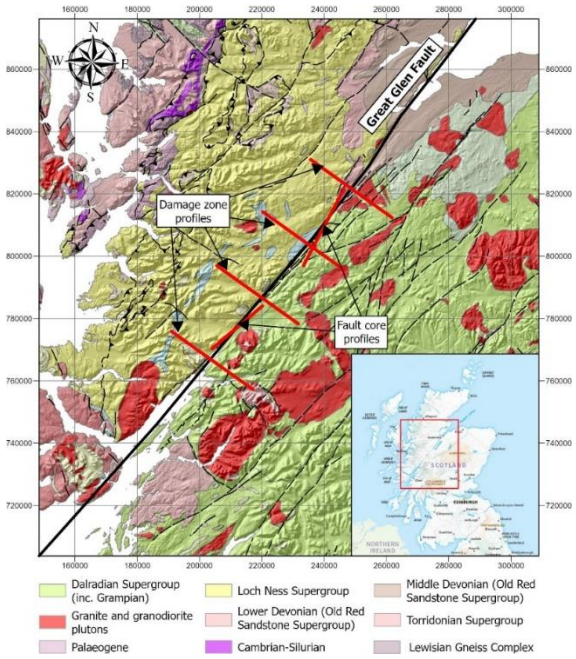

Figure 6*: Overview geological map of the Great Glen Fault and surrounding area. Contains OS data © Crown copyright and database rights 2023. OS AC0000824781 EUL. Contains BGS © UKRI. © UKP/Getmapping Licence No. UKP2006/01. NEXTMap Britain elevation data from Intermap Technologies.*

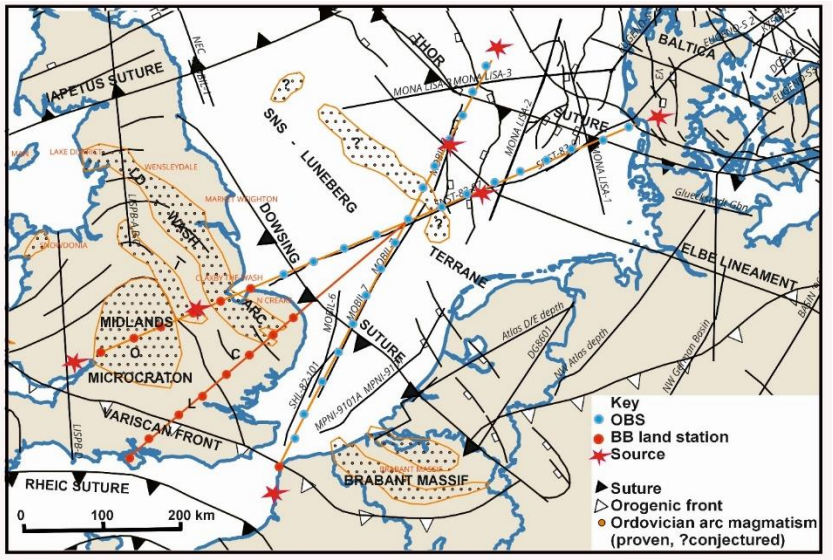

***Figure 7**: Outline structural map of Caledonian-Variscan basement of the southern North Sea and its surroundings, modified after Pharaoh (1999) and sources therein. Location of existing deep seismic reflection and refraction lines is shown. The geographical scope of the refraction experiment proposed here is indicated with red lines. Surface locations: C, Cambridge; L, London; O, Oxford; SNS, Southern North Sea.*

The Mantle and its Transition Zone

The UKI-Array offers a unique opportunity to probe the deep Earth. The mantle transition zone (MTZ) lies hundreds of kilometres below the surface and marks the change in properties between the upper and lower mantle (Cottaar & Deuss 2015). UKI-Array would allow us to image a region of the MTZ shaped by billions of years of mantle evolution (Helffrich et al., 2003), thereby removing the signal of mantle recycling and mixing near plate boundaries and providing an important global benchmark for geodynamical and mineral physics investigations. Broadband signals from the array would be used to construct Ps receiver functions to illuminate the 410 km and 660 km discontinuities that bound the MTZ, and the X-discontinuity (a sporadic mid-mantle discontinuity), with the resulting topographical variations providing insights into thermal and compositional anomalies.

Seismicity and Seismic Hazard

Seismic hazard in the UK and Ireland is generally low compared with more active tectonic regions, but earthquakes do occur beneath large areas of the UK and Ireland (Figure 8). Seismological analysis therefore remains essential for natural hazard management and monitoring, particularly for subsurface activities such as carbon capture and storage, geothermal exploitation, and tunnelling. It is also a critical requirement for the planning of proposed nuclear waste disposal facilities and new nuclear reactors. However, many factors currently impede seismic hazard analysis: 1) lack of resolution of earthquake

depths, 2) limited knowledge of fault geometries, 3) scarcity of well-constrained focal mechanism solutions, 4) variable completeness of seismic catalogues, and 5) limited knowledge about the state of stress and thus about which fault systems have the greatest potential to slip. Existing seismic hazard analyses do not explicitly account for fault sources, yet studies show that including faults yields more detailed and locally higher seismic hazard estimates, even in regions of low strain rate (e.g., Williams et al. 2022).

A backbone UKI-Array network (e.g., design component 1 or 4 in the companion paper, Curtis et al., 2026) could address current limitations, particularly in the Midlands and South-East of England, where coverage gaps likely lead to an underestimated seismic hazard (**Error! Reference source not found.** of Mosca *et al*., 2020). The array would also enable targeted investigations in regions with anomalously high seismic activity, such as northwest Wales, south Wales, and central Scotland, where seismicity often correlates poorly with mapped faults. The subsurface structure to depths of several kilometres is a critical factor in seismic hazard and risk assessments, particularly site attenuation effects. Yet, in the UK, the spatial variability of shear-wave velocity and attenuation is not accounted for in existing seismic hazard models (Rietbrock & Edwards 2019; Douglas et al., 2024). UKI-Array provides an opportunity to characterise subsurface geophysical structure at a scale previously unattainable, thereby directly improving forecasts of the hazard posed by future earthquakes. The array would also allow us to investigate how source processes (e.g., stress drop) control ground shaking, and to improve the estimation of target region characteristics and their associated uncertainties in the context of the hybrid stochastic-empirical method used for probabilistic seismic hazard assessment in the UK (Douglas et al. 2024). This would generate new understanding that drives a step change in our ability to characterise ground shaking and seismic hazard/risk, ultimately enhancing the cost-effectiveness and safety of critical infrastructure such as nuclear power plants.

Quantifying natural seismicity in urban environments is challenging. High levels of anthropogenic seismic noise generated by human activity, have historically deterred seismologists from deploying seismic instruments in cities around the world. It is nevertheless important to do so to improve understanding of seismic hazard, with applications in aquifer monitoring and urban engineering projects. London is a prime example of a city that would benefit, with recent studies indicating that London sits atop active faults that impact groundwater aquifer movements and are capable of generating earthquakes (Mason et al 2015; Morgan et al 2021). These are likely reactivated basement faults that are thought to have compartmentalised much of the sub-surface into small tectonic blocks, but it remains unclear how these fault systems connect and continue in the subsurface. Extending UKI-Array into the interior of cities will shed light on these and other important issues.

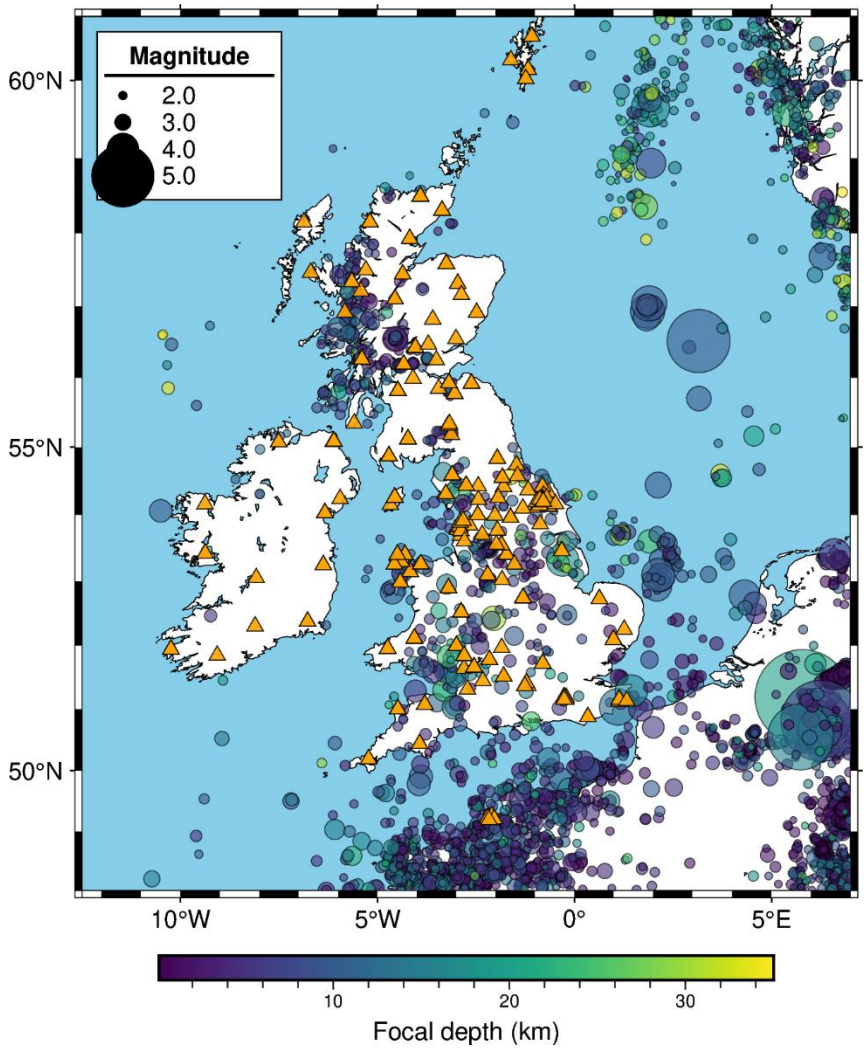

***Figure 8**. Earthquakes around the UK and Ireland. Earthquakes only include events with a magnitude larger than 2.0 and a depth of less than 35 km in the UK, Ireland and surrounding regions that occurred from 1992 to 2026 according to the International Seismological Centre (ISC) catalogue. Observation stations (triangles) only include seismic stations operated by the British Geological Survey (BGS), and Dublin Institute for Advanced Studies (DIAS).*

Infrasonics

Integrating low-frequency acoustic sensors (microbarometers) with the UKI-Array network would improve the characterisation of both natural and anthropogenic events. Seismic data in populated areas, such as across much of the UK and Ireland, are often contaminated by complex, time-varying noise. Co-located microbarometers can help to characterise this noise field and mitigate its effect on seismic data. Observations of air-to-ground coupled waves (such as those from distant volcanic eruptions, quarry blasts, and meteoroids) recorded on co-located seismometers and infrasound sensors would help to further our understanding of how atmospheric energy couples with and transfers to the ground. Furthermore, a joint seismo-acoustic component of UKI-Array would complement similar networks in

France and the Netherlands, forming a larger, multinational Western European acoustic network. A comparable seismo-acoustic network in the United States provided a unique and rich dataset that proved extremely useful not only to the geophysical community but also to other scientific disciplines (e.g., meteorologists exploring the properties of atmospheric gravity waves) and for educational outreach, which we might hope to mirror on this side of the Atlantic.

Stress, Fault Reactivation & Induced Seismicity in Offshore Sedimentary Basins

Understanding the present-day stress field is essential for safe subsurface energy storage and geothermal development (Williams et al., 2018), but quantitative constraints remain limited. Dense seismic reflection datasets from decades of hydrocarbon exploration have yielded a structural framework (>2,000 mapped faults and 20 horizons) in the Irish and Celtic Sea basins (e.g., Rodriguez-Salgado et al., 2020, 2023). UKI-Array could improve the detection and location of low-magnitude offshore earthquakes, particularly if suitable ocean-bottom seismometers were included. This could enable reliable focal mechanisms to be estimated, complementing three-dimensional fault maps from reflection datasets. Borehole test data could be used to reconstruct the present-day stress field, and through focused analyses in one or more priority basins (e.g., Kish Bank, Central Irish Sea, Cardigan Bay, St George's Channel, North and South Celtic Sea, and Fastnet), the refined stress models combined with mapped faults could be used to estimate the tendency for fault slip and dilation.

Earth Resources and Subsurface Storage

To aid the transition to cleaner energy and to mitigate future climate change, the UKI-Array will help to evaluate the subsurface potential to provide important Earth resources such as water, heat and critical minerals, and to safely store products such as hydrogen or waste carbon dioxide and nuclear fuel. In addition, induced seismicity is associated with a range of industries, and has been recorded historically during coal mining (e.g., Verdon et al., 2018), shale gas stimulation (e.g., Clarke et al. 2019), during large scale building and excavations (Butcher et al., 2021), and seismic signals are induced by wind turbines (Styles et al., 2005; Westwood and Styles, 2017), amongst others. Seismicity is indicative of both strain and stress changes and of potential future hazards, and the resulting seismic waves allow the solid subsurface to be interrogated for rock and fluid properties. UKI-Array will significantly enhance our ability to monitor seismicity, potentially contributing important information to future decision-makers in a variety of industrial contexts.

Geothermal Energy and Critical Mineral Prospectivity

The UK and Ireland have significant potential for geothermal energy across a range of depths and geological settings. Hot brines can be circulated through subsurface rocks via production and reinjection boreholes, or heated using closed-loop systems. In both cases, permeability and porosity control fluid flow, but conventional rock permeability is often too low for economic production, making fracture networks critical. Identifying these fractures requires detailed knowledge of subsurface stress, faulting, and seismicity. However, cost constraints often rule out active seismic surveys for low–medium enthalpy resources. UKI-Array would enable passive seismic imaging to characterise shallow structure, refine

stress-field estimates, and use seismic anisotropy and microseismicity to map fracture-prone zones and active faults. Magnetotelluric imaging would contribute additional constraints on porosity, alteration zones and fluid content at depth. In some regions, geothermal fluids may also contain critical minerals such as lithium. These could potentially be extracted alongside heat production if concentrations and flow rates are sufficient. Both heat, especially with respect to multi-kilometre deep, closed loop geothermal systems, and mineral distribution depend strongly on thermal structure, basement composition, and depth, which the UKI Array would help to better constrain.

Monitoring induced seismicity at offshore CCS sites

Carbon capture and storage (CCS) is a key part of the UK's net zero strategy. The UK government has issued more than 20 licenses for CO_2 appraisal and storage in offshore sedimentary formations around the UK (see Figure 9), with commercial CO_2 injection at some sites expected to begin by the late 2020s. Like all subsurface injection operations, CO_2 storage carries a risk of induced seismicity (e.g., Verdon et al., 2013), which could damage subsurface infrastructure and reservoir integrity or indicate a leaking reservoir. Induced seismicity can therefore pose an existential threat to subsurface industries (Verdon et al., 2025), making earthquake monitoring necessary to proactively manage these risks.

A reasonable objective for UKI-Array would be to use dense sensor arrays to support seismic monitoring of offshore CCS sites, such as to identify reflected, refracted, or converted seismic phases that could be used to constrain earthquake depths using optimised array designs for near operational CCS sites (Strutz & Curtis, 2025). The array could not only monitor the offshore Humber region in the east of Figure 9**,** but potentially extend to international CO_2 stores through coordination with European partners, e.g., see Figure 4 of the companion paper, Curtis et al., (2026).

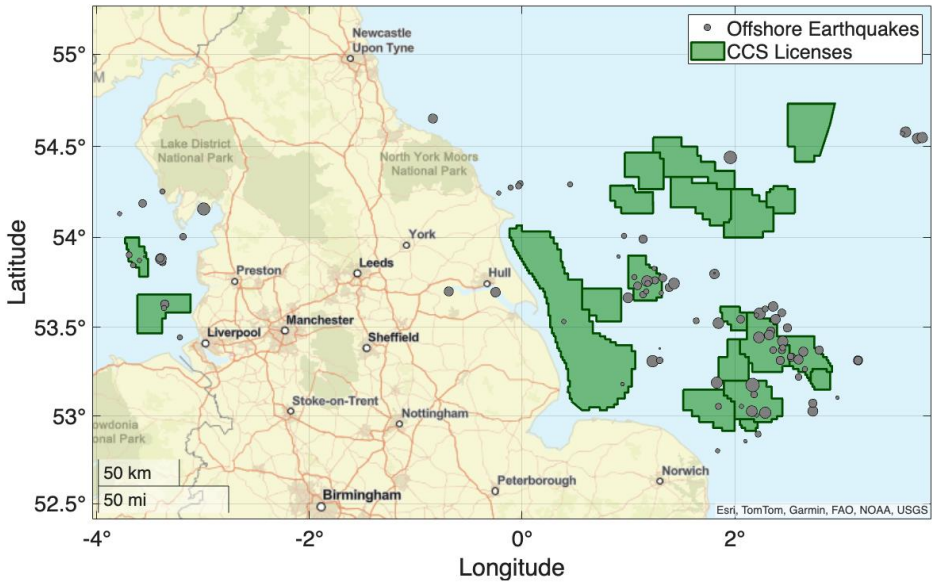

Figure 9*: Map showing carbon capture and storage license block locations in the Irish Sea and southern North Sea (green polygons). Locations of offshore earthquakes recorded since 01/01/2000 are also shown (grey circles).*

Outreach and Public Engagement

UKI-Array provides an opportunity to engage the public with geoscience in their local communities and 'back yards'. Outreach could include installing seismometers at accessible sites such as schools and museums, participating in science festivals, and engaging with the media widely. Ground-motion visualisations from local and distant earthquakes would be shared for education and outreach, alongside mapped products such as subsurface seismic velocity models integrated into the proposed 3D Atlas, 3D-printed models, and interactive mapping platforms such as those of the British Geological Survey and equivalent Irish organisations. The project's UK- and Ireland-wide footprint would enable direct engagement with schools during equipment deployment and maintenance. Public engagement, especially with children and parents, would be a core objective. Student numbers in terrestrial Geophysics degrees have declined sharply over the past two decades, leading to degree and course closures despite strong job prospects for graduates (Jenkins et al., 2024). Through sustained publicity, UKI-Array offers a timely opportunity to raise the profile of Geophysics and to directly inspire school-age audiences across the UK and Ireland.

Discussion

The opportunities and applications discussed here are by no means exhaustive – without doubt, other academic and scientific questions of interest would be stimulated by the data captured. The project would become even more impactful by attracting private-sector partners, such as those in the geotechnical, engineering, and subsurface gas/fluids/minerals extraction/storage sectors. Once a clear route to funding the UKI-Array has been identified, other funding, research and application partners in the private and public sectors will be integrated into proposals.

In these two companion articles, we have not narrowed down specific designs for the array, nor have we discussed deployment, logistics, or timing. These will all be subject to further community discussion and consent, and to the availability of people to help in the field.

This paper and its companion (Curtis et al., 2026) outline a vision. The Geophysical community has lent its support to advance the project to the proposal stage, and attracting funding will clearly be key to practical progress. Ultimately, though, the implementation of UKI-Array and the opportunities that arise will materialise because the community continues to show enthusiasm and contribute time and energy to the project.

In the past, much UK geophysical research has been carried out by individuals and groups working in various small alliances and networks. This contrasts with the Astronomy community, which participates in large international collaborations that are essential to achieving hugely expensive advances in instrumentation and data processing, such as the James Webb Space Telescope. Possibly the most significant challenge and change offered by the UKI-Array is therefore cultural: it encourages the entire UK and Irish geophysical communities to work supportively together, and with neighbouring international partners, towards a single collaborative endeavour. Surely this will benefit us all for decades to come.

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