

RAFAEL KENJI HOROTA, PhD

Digital Geoscientist | Digital Outcrop Models | UAV Photogrammetry | Virtual Field Experiences | GeoAI and XR

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PROFESSIONAL PROFILE

Dr Rafael Kenji Horota is a Brazilian geologist and digital geoscience researcher working at the intersection of field geology, geoinformatics, three-dimensional geological documentation, immersive technologies and geoscience education. His work integrates Digital Outcrop Models, UAV photogrammetry, 360-degree field imagery, web-GIS, Cesium-based virtual geological environments, virtual reality, computer vision and GeoAI-ready geological datasets. His doctoral research at the University of Bergen and the University Centre in Svalbard developed and evaluated digital field representations for High Arctic geoscience teaching, field preparation, post-field interpretation and long-term access to remote geological sites.

RESEARCH FOCUS

Digital geology and Digital Outcrop Models for geological interpretation, teaching and field-data preservation.

Multiscale virtual geological environments linking DOMs, geologic maps, satellite imagery, regional context, samples, interpretations and educational resources.

GeoAI-ready geological datasets, including spatially grounded annotations, interpretation confidence, human-in-the-loop validation and responsible data provenance.

Virtual field experiences, immersive field learning, VR, web-GIS and Cesium 3D globe environments for geoscience education and geoheritage communication.

Outcrop-to-subsurface translation using high-resolution digital outcrop analogues, synthetic visualization, uncertainty metrics and quantitative structural/sedimentological interpretation.

EDUCATION

PhD in Earth Sciences. University of Bergen, Norway, 2025. Thesis: The Digital Geoscience Revolution - implications for field learning and research in the High Arctic. Research conducted in collaboration with the University Centre in Svalbard (UNIS).

MSc in Applied Computing. Universidade do Vale do Rio dos Sinos (UNISINOS), Brazil. Research on immersive virtual field trips and Digital Outcrop Models.

BSc in Geology. Universidade do Vale do Rio dos Sinos (UNISINOS), Brazil.

ACADEMIC AND RESEARCH APPOINTMENTS

2026-present - Researcher, VizLab/UNISINOS, Brazil. Research and development in digital geology, photogrammetry, immersive visualization, computer vision, GeoAI, Digital Outcrop Models and virtual geological environments.

2025 - Universitetslektor / course responsible, Department of Arctic Geology, University Centre in Svalbard, Norway. Course responsible for AG-214 - The Geological Evolution of Svalbard, including lectures, field activities, GIS, UAV photogrammetry and student virtual field-guide projects.

2021-2025 - Doctoral researcher, University of Bergen and University Centre in Svalbard, Norway. Development, implementation and evaluation of digital field representations for High Arctic geoscience education and research.

Previous professional experience. Geological Survey of Brazil, mineral exploration, geological mapping, core logging, underground mapping, metrology/instrumentation and teaching assistance in mineralogy and igneous/metamorphic petrology.

COMPETITIVE GRANTS AND FUNDED PROJECTS

2023 - Research Council of Norway / Svalbard Science Forum - Arctic Field Grant, DigSouth. Digitizing Svalbard: Hornsund and Storfjorden DOM Data Acquisition Campaign and Virtual Tour Development for Educational Research. Amount: NOK 120,000. Role: project owner / PI.

2022 - Research Council of Norway / Svalbard Science Forum - Arctic Field Grant, DigHopen. Digitizing Svalbard Woodfjorden's DOM Data Acquisition Campaign and Virtual Field Guide Development for Educational Research. Amount: NOK 100,000. Role: project owner / PI.

2021 - iEarth Centre for Integrated Earth Science Education - SEED project. There and Back Again: Svalbard and Beyond Edition. Amount: NOK 50,000. Role: project lead.

Collaborative funded projects and contributions

SvalDEM - Digital elevation models of glaciers and their forefields in the changing High Arctic. iEarth SEED project, NOK 10,500, 2021. Authors: Aga Nowak and Rafael K. Horota; role: UAV data acquisition, photogrammetric reconstruction and accessible 3D glacier models.

FROST - Fieldwork instructional Resources for Students and Teachers. iEarth SEED project, NOK 49,505, 2020. Role: contributed to the virtual field-trip concept and Kapp Linne / Isfjord Radio prototype later expanded through VRsvalbard.

UNESCO/IUGS IGCP proposal development, 2026. Main project leader for Brazil-Chile digital geosite and GeoAI-ready volcanic geoheritage proposal under development through UNISINOS/VizLab.

PEER-REVIEWED PUBLICATIONS

- Galland, O. et al., including Horota, R.K. (2025). Stratigraphic Influence on Emplacement and 3-Dimensional Structure of a Large Mafic Sill in Sedimentary Strata. *Basin Research*, 37(4), e70047. doi: 10.1111/bre.70047
- Horota, R.K. et al. (2024). VRsvalbard - a Photosphere-Based Atlas of a High Arctic Geo-Landscape. *First Break*, 42(4), 35-42. doi: 10.3997/1365-2397.fb2024029
- Senger, K. et al., including Horota, R.K. (2024). Arctic Tectonics and Volcanism: a multi-scale, multi-disciplinary educational approach. *Geoscience Communication*, 7, 267-295. doi: 10.5194/gc-7-267-2024
- Horota, R.K. et al. (2023). West Spitsbergen fold and thrust belt: A digital educational data package for teaching structural geology. *Journal of Structural Geology*, 167, 104781. doi: 10.1016/j.jsg.2022.104781
- Horota, R.K. et al. (2023). An Immersive Virtual Field Experience Structuring Method for Geoscience Education. *IEEE Transactions on Learning Technologies*, 16(1), 121-132. doi: 10.1109/TLT.2022.3207089
- Senger, K. et al., including Horota, R.K. (2022). Digitising Svalbard's Geology: the Festningen Digital Outcrop Model. *First Break*, 40(3), 47-55. doi: 10.3997/1365-2397.fb2022021
- Senger, K. et al., including Horota, R.K. (2021). Teaching with digital geology in the High Arctic: opportunities and challenges. *Geoscience Communication*, 4, 399-420. doi: 10.5194/gc-4-399-2021
- Marques Junior, A. et al., including Horota, R.K. (2021). Deep Learning Application for Fracture Segmentation Over Outcrop Images from UAV-Based Digital Photogrammetry. *IEEE International Geoscience and Remote Sensing Symposium (IGARSS 2021)*. doi: 10.1109/IGARSS47720.2021.9553232

PREPRINTS, CHAPTERS AND MANUSCRIPTS

Horota, R.K., Eide, C.H., Senger, K., Jonassen, M.O. and Vander Kloet, M.A. (2025). Digital Field Representations as a Holistic Approach to Experiential Learning in High Arctic Geoscience Field Education. *EGUsphere* [preprint]. doi: 10.5194/egusphere-2025-2248

Horota, R.K. and Senger, K. Virtual Outcrop Models and Virtual Reality. Book chapter submitted/in preparation for a volume on virtual outcrops and digital geology.

Horota, R.K. et al. Comparing UAV-SfM photogrammetry and heli-LiDAR scanning for Digital Outcrop Model generation in High Arctic conditions. Manuscript in preparation.

Horota, R.K. et al. Bockfjorden Volcanic Complex digital mapping, geosite documentation and virtual field-guide development. Manuscript/project in preparation.

SELECTED DIGITAL RESEARCH OUTPUTS

VRSvalbard. Founder/lead developer of a web-GIS platform integrating virtual field tours, 360-degree imagery, Digital Outcrop Models, geological maps, satellite imagery and multimedia teaching resources for Svalbard.

Svalbox contributions. Contributor to Svalbox digital geological datasets, including 360-degree image repositories, Digital Outcrop Models and virtual field resources used by UNIS courses and international collaborators.

West Spitsbergen Fold-and-Thrust Belt educational package. Lead author of an open digital teaching package combining DOMs, GIS data, geological interpretation and structural geology exercises.

Svalbard Games. Co-developer, with Daniel Kramer and Kim Senger, of an Unreal Engine geological learning environment designed for Arctic geology and geophysics teaching at UNIS.

MOSIS immersive geological environments. Research and development involving optimization, integration and interpretation of Digital Outcrop Models in desktop and immersive VR environments at VizLab.

Cesium-based virtual geological tours. Development of multiscale virtual tours connecting regional geology, DOMs, samples, field observations, interpretations, educational content and geoconservation information.

Smart Outcrop. Concept and prototype development for AI-assisted digital outcrop environments where users explore 3D geological sites and interact with a spatially grounded AI field instructor.

FIELD CAMPAIGNS AND DATA ACQUISITION

Svalbard High Arctic digital field campaigns, 2021-2025: acquisition of UAV photogrammetry, 360-degree photospheres, DOMs and geological field data across Festningen, Billefjorden, Deltaneset, Hornsund, Storefjorden, Bockfjorden, Woodfjorden and related localities.

Bockfjorden Volcanic Complex, 2023: digital documentation of Sverrefjellet, Sigurdfjell and Halvdanpiggen volcanic outcrops, including UAV photogrammetry, geomorphological context and virtual field-guide development.

Botneheia digital outcrop benchmarking: comparison of UAV-SfM and helicopter-LiDAR datasets, DEM validation, ICP alignment and M3C2 point-cloud analyses.

Brazilian digital geology case studies: development of DOM, virtual field experience and Cesium-based geosite documentation workflows for Brazilian geological and geoheritage sites.

TEACHING, SUPERVISION AND CAPACITY BUILDING

Course responsible for AG-214 - The Geological Evolution of Svalbard, University Centre in Svalbard, 2025.

Course responsible for AG-222 - Integrated Geological Methods, University Centre in Svalbard, 2022.

Teaching and field support in UNIS Arctic geology and geophysics courses, including AG-209, AG-210, AG-214, AG-220, AG-222, AG-336/836, AG-351/851 and AGF-213.

Training in GIS mapping, UAV survey planning, photogrammetric processing, Digital Outcrop Model interpretation, virtual field-guide design and Arctic field logistics.

Experience mentoring student field projects, term projects, drone-processing reports, virtual geological-guide assignments and research data production.

No completed formal MSc or PhD supervision to date; extensive experience in course-based student mentoring, postgraduate field training and collaborative research supervision.

TECHNICAL EXPERTISE

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| Field and acquisition | Geological mapping; UAV survey planning; terrestrial and aerial photogrammetry; 360-degree and stereoscopic imagery; structural measurements; field-data management. |
| 3D data and point clouds | Digital Outcrop Models; meshes; point clouds; DEMs; model decimation; texture optimization; spatial registration; ICP; M3C2; CloudCompare. |
| Geospatial technologies | ArcGIS Pro; QGIS; CesiumJS; Cesium ion; web-GIS; coordinate systems; raster/vector processing; geospatial data integration. |
| Immersive environments | Virtual reality; MOSIS; desktop VR; 360-degree virtual tours; Unreal Engine educational environments; digital-twin concepts. |
| GeoAI and computer vision | Geological image segmentation; fracture detection; spatially grounded RAG concepts; multimodal geological datasets; human-in-the-loop validation. |
| Open science and data | FAIR-oriented documentation; open educational data packages; digital geological repositories; interoperable metadata; international data collaboration. |

INTERNATIONAL COLLABORATION

Collaborations include UNISINOS/VizLab, University of Bergen, University Centre in Svalbard, University of Oslo, Svalbox, iEarth, UiO Drone Lab, NHM Oslo, NGI, UiT, Brazilian geoscience groups, UNESCO Global Geopark partners in Brazil and Chile, and international digital geology, photogrammetry and Arctic Earth science networks.