Evidence of structurally-controlled fluid expulsion from the Amazon deep-sea fan

Daniel Praeg*[1,2], Sébastien Migeon[1], Cleverson Silva[3], A. Tadeu Dos Reis[4], Jenny Trevisan[1], Adolpho Augustin[5], Kelvin Ikenna Chima[2], Alexandre Dano[1], Aurélien Gay[6], Christian Gorini[2], João Marcelo Ketzer[7], Maria Alejandra Pivel[8], Jeffrey Poort[2], Christian Stranne[9], and Vikram Unnithan[10]

[1]Géoazur – Université Côte d'Azur (UCA), Observatoire de la Cote d'Azur, Institut de recherche pour le développement [IRD], CNRS – France

[2]Institut des Sciences de la Terre de Paris (ISTeP) – Institut National des Sciences de l'Univers, Sorbonne Universite, Centre National de la Recherche Scientifique – France

[3]Fluminense Federal University, Niterói, RJ, Brazil – Brésil

[4]Universidade do Estado do Rio de Janeiro (UERJ) = Rio de Janeiro State University, RJ, Brazil – Brésil

[5]Universidade do Vale do Rio dos Sinos, São Leopoldo, RS, Brazil – Brésil

[6]Géosciences Montpellier – Institut National des Sciences de l'Univers, Centre National de la Recherche Scientifique, Université des Antilles, Université de Montpellier – France

[7]Linnaeus University [Kalmar, Sweden] – Suède

[8]Universidade Federal do Rio Grande do Sul [Porto Alegre, RS, Brazil] – Brésil

[9]Department of Geological Sciences, Stockholm University, Sweden – Suède

[10]Jacobs University = Constructor University, Bremen, Germany – Allemagne

Résumé

The growth of the Amazon fan has been accompanied by recurrent fan-wide megaslides, and by gravitational collapse on shale detachments to form extensional and compressional belts across the shelf and upper slope, respectively. Seismic datasets show the compressional belt (500-2250 m water depth) to contain a gas hydrate system characterised by bottom-simulating reflection (BSR) patches aligned with thrust-folds, in places rising towards vent-like seafloor morphologies. Multibeam data acquired in 2016 across part of the belt revealed dozens of gas flares rising from seafloor mounds. The wider extent of degassing is unknown due to a lack of acoustic imagery, notably below the compressional front. Here we examine fluid expulsion from the Amazon fan using acoustic data acquired in water depths of 100-4100 m during the 2023 AMARYLLIS-AMAGAS I campaign, and 3D seismic data available across parts of the upper slope (ANP Brazil). Over 400 gas flares are identified in depths of 100-1900 m, with peak abundance near the upper limit of the methane hydrate stability zone (MHSZ) in depths of 570±40 m. About half of flares rise from mounds and/or depressions, half from areas of smooth or faulted seafloor. A semi-automated training approach was used to capture sub-circular morphologies from bathymetric data (4-50 m grids) for morphometric analysis. Over 500 features are identified in depths of 275-2265 m, comprising mounds (59%), complex forms (28%) and depressions (13%); the majority ($>$ 96%) are . Our results indicate

*Intervenant

widespread fluid expulsion from the Amazon fan within the extensional and compressional belts, versus a lack of evidence for venting in greater water depths. The primary control on degassing of the fan appears to be gravity-driven tectonism, which provides pathways for fluid escape within and above the MHSZ. This is a contribution to studies of gas hydrate dynamics and slope stability in the context of the MEGA project *(ANR-22-CE01-0031).*

Mots-Clés: submarine fans, multibeam imagery, 3D seismic, water column gas flares, seafloor fluid vents, morphometric analysis