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Volcaniclastic Deep-water Facies and Architecture of an Arc Adjacent Lobe Fan System: The Mistaken Point Formation, St. John's, Newfoundland

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Summary

The Mistaken Point Formation (MPF) is a 400m thick late Neoproterozoic siliciclastic-volcaniclastic unit that crops out in the Avalon Zone of Newfoundland and is recognized as one of the world's leading Ediacaran fossil-bearing deep-water successions [1,3,4]. The MPF is the uppermost part of a thick succession of the volcaniclastic submarine fan strata of the Conception Group [1,5], deposited at or near the transition of a fore-arc to foreland basin (Fig 1). Thus, MPF strata can provide insight into whether the basin transformation affected key elements of the local sedimentary environment during MPF sedimentation, including turbidity currents, bottom currents, and hemipelagic. The lower Middle Cove Member is defined by medium-bedded turbidites with minor thick-bedded green sandstone, massive siltstone with abundant volcanic ash and lapilli. The upper Hibbs Cove member is defined by medium beds of red-green siltstone interbedded with thin-to-medium beds of red-green sandstone with local conglomerate units and minor volcanic layers. Fourteen subfacies (Fig 3) from over twenty stratigraphic sections were recognized, revealing details of sedimentation processes and paleoenvironmental conditions. Detailed stratigraphy, petrography, and architectural analysis were integrated, supporting a submarine fan depositional system consisting of four lobe facies associations (FA1-4), which are, from proximal to distal with respect to the center of the lobe: the lobe axis, off-axis lobe, lobe fringe, and distal lobe fringe. These, then stack to form three lobe complexes (LC1-3). The lobe stacking pattern in the MPF succession suggests a variation in the rate of sediment influx through time, mainly due to the progressive deceleration of sediment supply from feeder channels. In each LC in the MPF, 'lobe *abandonment* or *retrograding'* compensational stack [6,7,8] is distinguished by an overall backstepping trend (thinning-fining upward successions) for about 20-30 m in thickness and up to hundred m lateral width.
The abundance of tuff and tuffaceous strata reflects the volcanically active nature of sedimentation adjacent to an island arc. The frequent occurrence of thin laminated ash layers suggests deposition by hemipelagic fall out of volcanic ash from common discrete eruptions (Fig 2). Most MPF strata were evidently deposited by concentrated density flows to low-energy turbidity currents, based on the widespread occurrence of graded beds and Bouma Sequences. Furthermore, the lack of wave-generated structures, and paucity of channels and erosion indicate that deposition occurred in a deep-water setting on a generally flat submarine fan. The presence of thick massive and laminated mudstone in some areas indicates ponded turbidity current which suggests a deposition in generally semiconfined basin. Moreover, the abundance of irregular post-depositional stratification further reflects instability in gravity flow deposits caused by fluidization following rapid sedimentation.

The stratigraphy of the MPF is characterized by an overall upward reduction in sediment concentration and flow energy. This transition of flow energy is exhibited by a gradual decrease in overall sediment grain size, upward loss of unidirectional current sedimentary structures, and the absence of erosional scours in the upper Hibbs Cove Member. The sand-to-mud ratio and the presence of multiple stacked lobe complexes suggest a sand-rich lobe system with sediment delivery from multiple feeder channels or sources [8]. Nevertheless, paleocurrent measurements collected from current ripples yield a consistent S-SW direction. This study highlights the sedimentary facies, architecture, and flow processes (Fig.1) in a volcanoclastic arc-adjacent setting at or near the transition to a foreland basin, thereby providing details of the morphodynamic response of submarine fans to basin transformation and fluctuations in sediment supply.

Method / Workflow

A field-based study is chosen to examine the siliciclastic-volcaniclastic rocks from detailed stratigraphic measurements at the bed scale (~5 cm resolution) from 14 measured sections across the Northern Avalon Peninsula. Architectural analysis was generated by semi-autonomous aerial drone photogrammetry in 4 outcrops with thickness ranges from fifteen to a few hundred meters. A total of 60 samples were analyzed for thin-section petrography (standard and polished thin-sections) to help determine micro-scale textures (microfacies) and mineralogical composition. In addition, SEM-EDX microscopy was utilized to study the mineralogy composition, particularly to differentiate clay matrix. An ongoing SEM-CL and Zircon U-Pb geochronology study aims to reinforce stratigraphic correlations, constrain maximum depositional ages, and reveal changes in sediment sourcing and routing linked to basin transformation. All these analyses were undertaken using the established laboratory at Memorial University. Geology and image-based software are used for data interpretation.

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References

1.King, A. F. Geology of The St. John's Area: Geological Survey Branch Department of Mines and Energ y: 1990
2.King, A. F. Geology of the Avalon Peninsula, Newfoundland (parts of IK, 1L, 1M, IN and 2C). Newfoundland: Department of Mines, Map 88-01. 1988
3.Matthews, J. J., et.al. A Chronostratigraphic Framework for the Rise of the Ediacaran Macrobiota: 2020
4.Benus, A. P. Sedimentological context of a deep-water Ediacaran fauna (Mistaken Point, Avalon Zone): New York: 19884. Matthews, J. J., et.al. A Chronostratigraphic Framework for the Rise of the Ediacaran Macrobiota: . Bulletin of the Geologi: 20205.
5.Wood, D. A. Paleoenvironmental analysis of the late Neoproterozoic Mistaken Point and Trepassey formations: Canadian Journal of Earth Sciences: 2003
6.Prelat, A., Hodgson, D.M., Flint, S.S. Evolution, Architecture and Hierarchy of Distributary Deep -water Deposits: A High-Resolution Outcrop Investigation from The Permian Karoo Basin. Sedimentology 56: 2009
7.Zhang, et.al. Research on the architecture of submarine-fan lobes in the Niger Delta Basin, offshore West Africa. Journal of Palaeogeography, 2016
8.Jamil, M., et. al. Facies Heterogeneity and Lobe Facies Multiscale Analysis of Deep -Marine Sand-Shale Complexity in the West Crocker Formation. MDPI: 2021

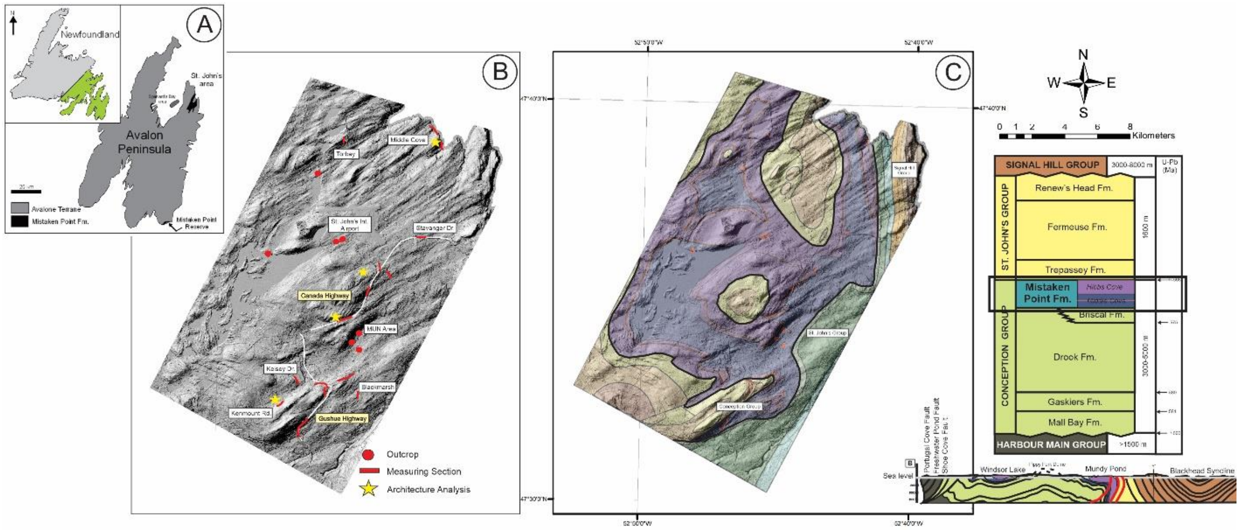

Fig 1. (A) The Avalon Peninsula, southeast Newfoundland, showing the distribution of Mistaken Point Formation (MPF) in the north-eastern margin. **(B)** Map of Mistaken Point area, including access route and sections measured in this study **(C)** Regional stratigraphy with geochronological data and cross-section of St. John's area modified after [2,3,4]. Regionally comprises Neoproterozoic magmatic arc and sedimentary cover sequences sub- to deep marine siliciclastic and volcaniclastic rocks dominated by volcanogenic turbidites Conception Group (this study) overlain by shallow marine to deltaic St. John's group and fluvial to alluvial fan Signal Hill Group [1,3,4,5]

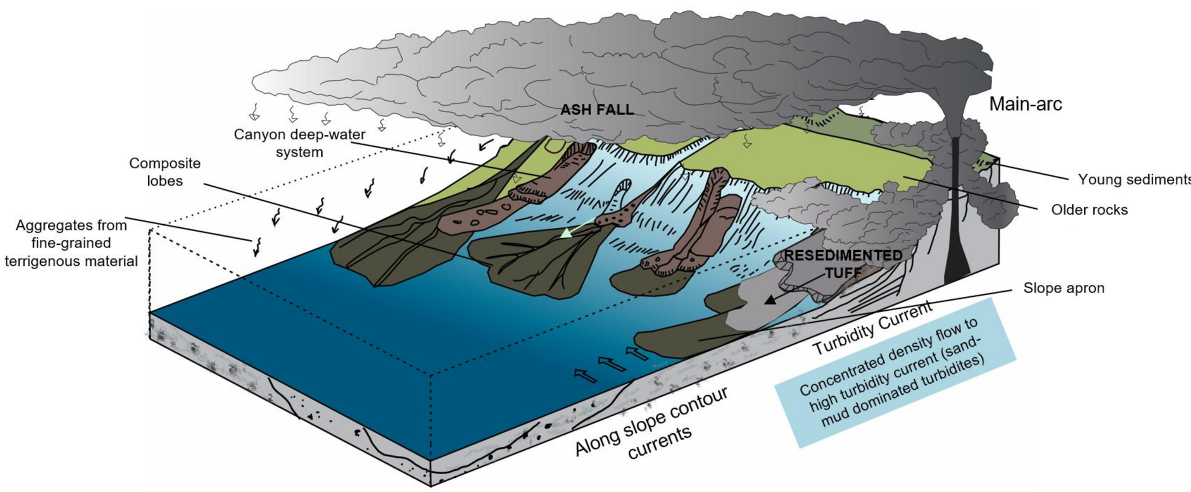

Fig 2. Conceptual Model of the MPF Depositional System. MPF represents an active period of volcanic activity concurrent with turbidity current, with an overall reduction of flow energy and degree of volcanic supply through time. Stratigraphic evidence suggests MPF strata were deposited by concentrated density flows to low-energy turbidity currents, which are represented by facies conglomerate, sandstone, and mudstone. Two different mechanisms of volcanic ash deposit: (1) hemipelagic settling by wind-derived and suspension (2) resedimented and transported downslope with turbidity current, resulted in three sub facies of tuff. Along slope process (bottom current deposit) may occur deposited heterolithic facies.

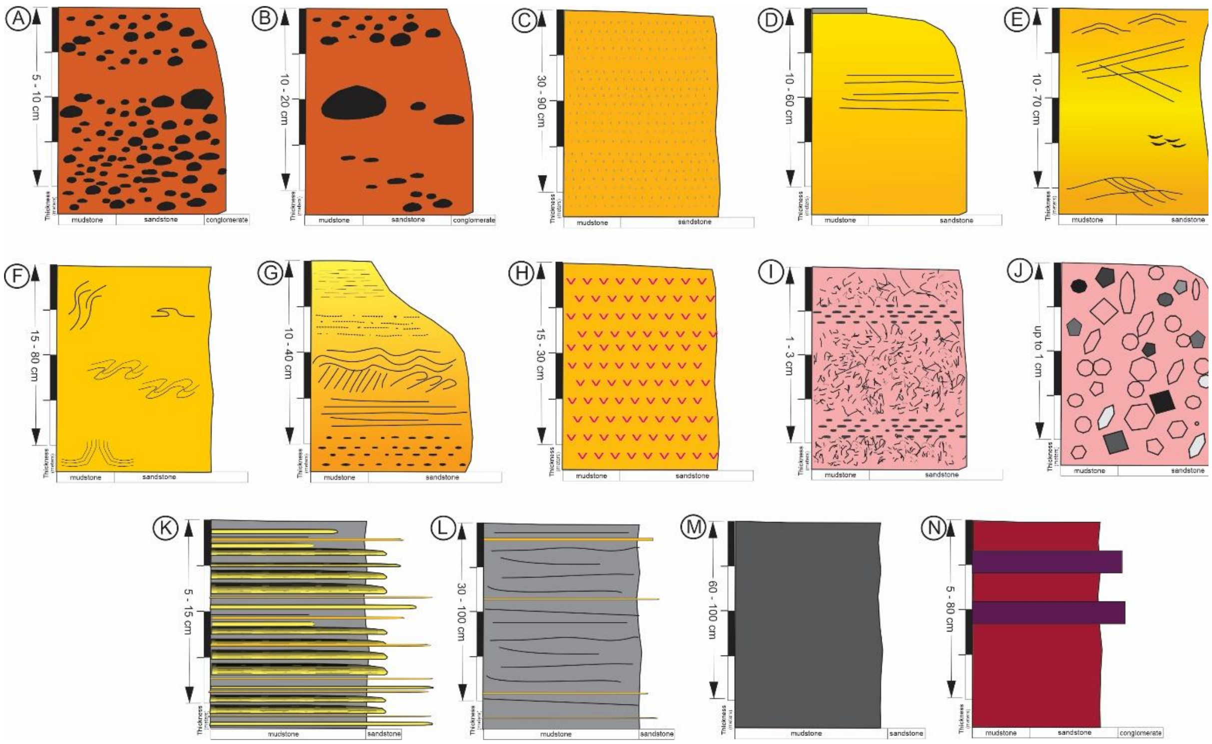

Fig 3. Facies Distribution in the MPF is divided into fourteen subfacies, as follow **(A)** Clast-supported Conglomerate **(B)** Matrix-supported Conglomerate **(C)** Massive sandstone **(D)** Normal-graded (Parallel-laminated) Sandstone **(E)** Cross-laminated Sandstone **(F)** Irregular Post-depositional Stratification **(G)** Bouma Sequences **(H)** Tuffaceous Sandstone **(I)** Ash-Lapilli Crystal Tuff **(J)** Phenocryst Tuff **(K)** Heterolithics sand-mud layers **(L)** Laminated Siltstone **(M)** Massive Mudstone **(N)** Red-Purple Units