

BaSIC: A Bayesian Inversion Model for Basalt Source Investigation and Characterization

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Text S1. Model Testing

Due to the growing use of Bayesian statistics in petrology, many packages and tools are available to conduct the types of inversion utilized in BaSIC. When BaSIC was under development, the model was constructed using both UltraNest, (a nested sampling Bayesian inference algorithm), and Zeus MCMC (Karamanis et al., 2021; Karamanis and Beutler, 2021).

Developing BaSIC utilizing two sampling methods to construct the Bayesian evidence allowed us to gain a higher degree of confidence in our model. Though the distribution of the outputs were not completely identical to those obtained with UltraNest, the overall spread, averages, and standard deviations are reproduced within error. Ultimately, UltraNest was chosen for the primary model due to computational and plotting speed.

Table S1. Mineral/melt partition coefficients for each element of interest with respect to the host mineral.

	Gnt/Liq (1 σ) ^a	Ol/Liq (1 σ) ^a	Cpx/Liq (1 σ) ^a	Opx/Liq (1 σ) ^a	Sp/Liq (1 σ) ^a	Amph/Liq ^b
D _{Mn}	1.241 (17)	0.781 (14)	0.768 (18)	0.640 (12)	0.46 (3)	0.82 (26)
D _{Fe}	0.654 (7)	1.034 (16)	0.488 (10)	0.546 (10)	0.95 (6)	2.1 (13)
D _{Zn}	0.213 (9)	0.96 (4)	0.333 (17)	0.451 (17)	5.2 (5)	0.60 (23)
D _{Sc}	5.98 (11)	0.150 (3)	0.84 (4)	0.495 (11)	0.058 (8)	4.2 (29)
D _{Ga}	0.390 (7)	0.0260 (9)	0.357 (13)	0.299 (10)	6.5 (5)	0.60 (4) ^c
D _{Co}	0.83 (2)	2.37 (9)	0.86 (4)	1.29 (14)	3.0 (6)	4.5 (36)

The error (in parentheses) is the one standard deviation and is given in terms of the least unit cited (e.g., 1.241 (17) represents 1.241 ± 0.017 , and 3.0 (6) represents 3.0 ± 0.6). Standard deviations on partition coefficients are not used in the calculations presented in this article.

^a Partition coefficients are sourced from Davis et al. (2013).

^b. D^{amph/liq} for Mn, Fe, Zn, Sc, and Co were experimentally determined by Ezad et al. (2025) for amphibole-basanite equilibrium.

^c. D^{amph/liquid} for Ga was experimentally determined by Adam and Green (2006) for amphibole-basanite equilibrium

Table S2. Aitchison mean outputs and plume characteristics for various Iceland data compilations and recent Reykjanes Peninsula eruptions.

[illegible]

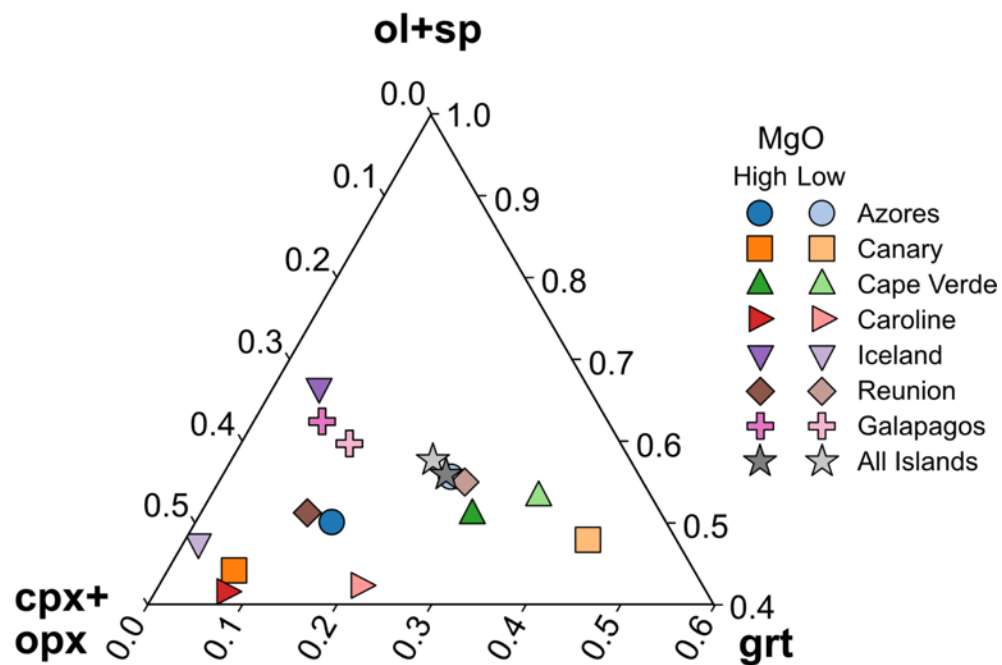


Figure S1. Ternary scatter diagram with modeled outputs considering high (>10 wt.%) versus low (<10 wt.%) MgO suites. Locations represented on this plot were selected based on the abundance of both high and low MgO data from a given island.

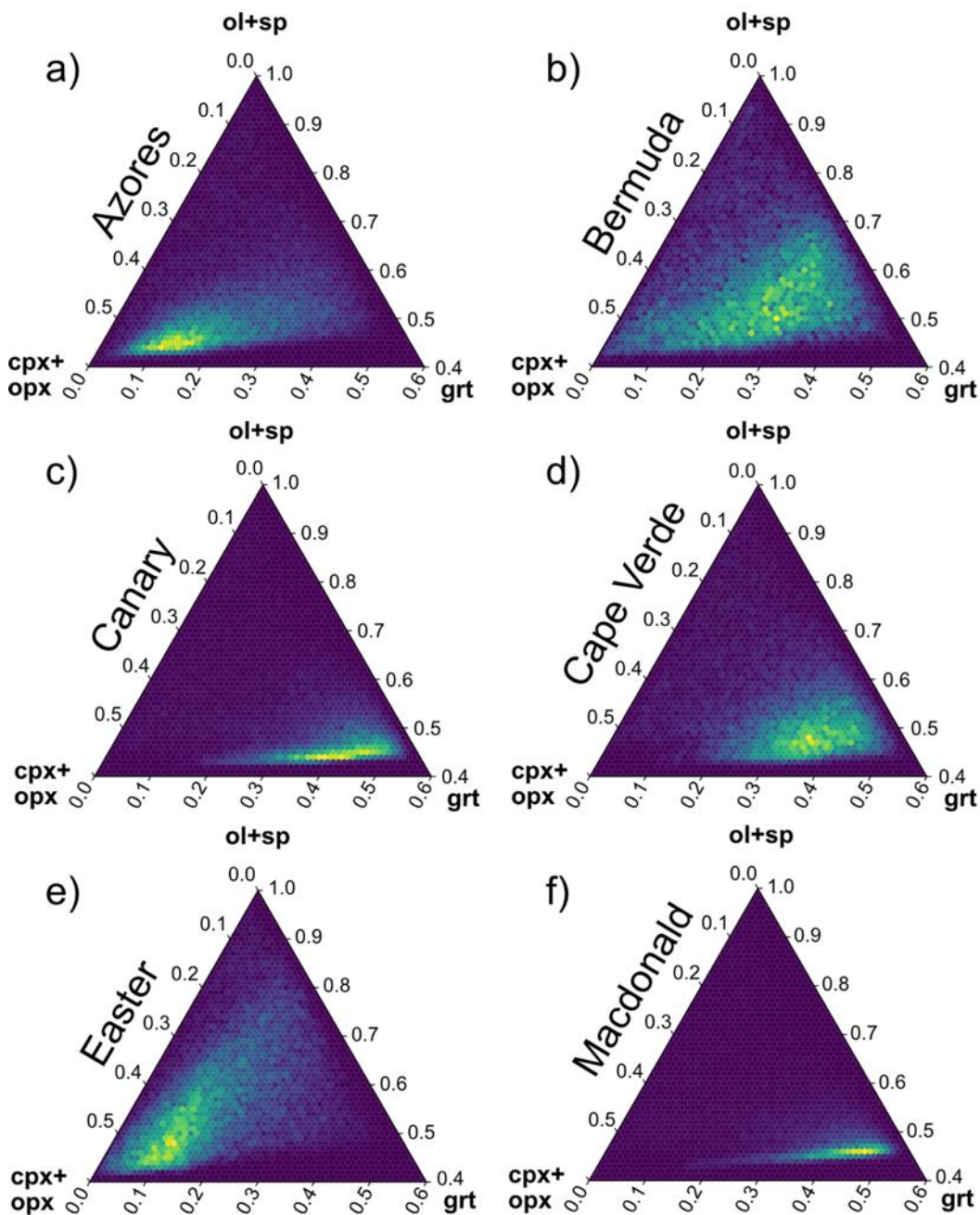


Figure S2. Density plots showing the output source mineralogies that best reproduced the average basalt elemental ratios in the ternary diagram Olivine + Spinel – Orthopyroxene + Clinopyroxene – Garnet for (a) Azores, (b) Bermuda, (c) Canary, (d) Cape Verde, (e) Easter, (f) Macdonald, (g) Marquesas, (h) Meteor-Shona, (i) Pitcairn, (j) Reunion, (k) Samoa, (l) Tristan-Gough, (m) Tasmanid-Tasman Central.

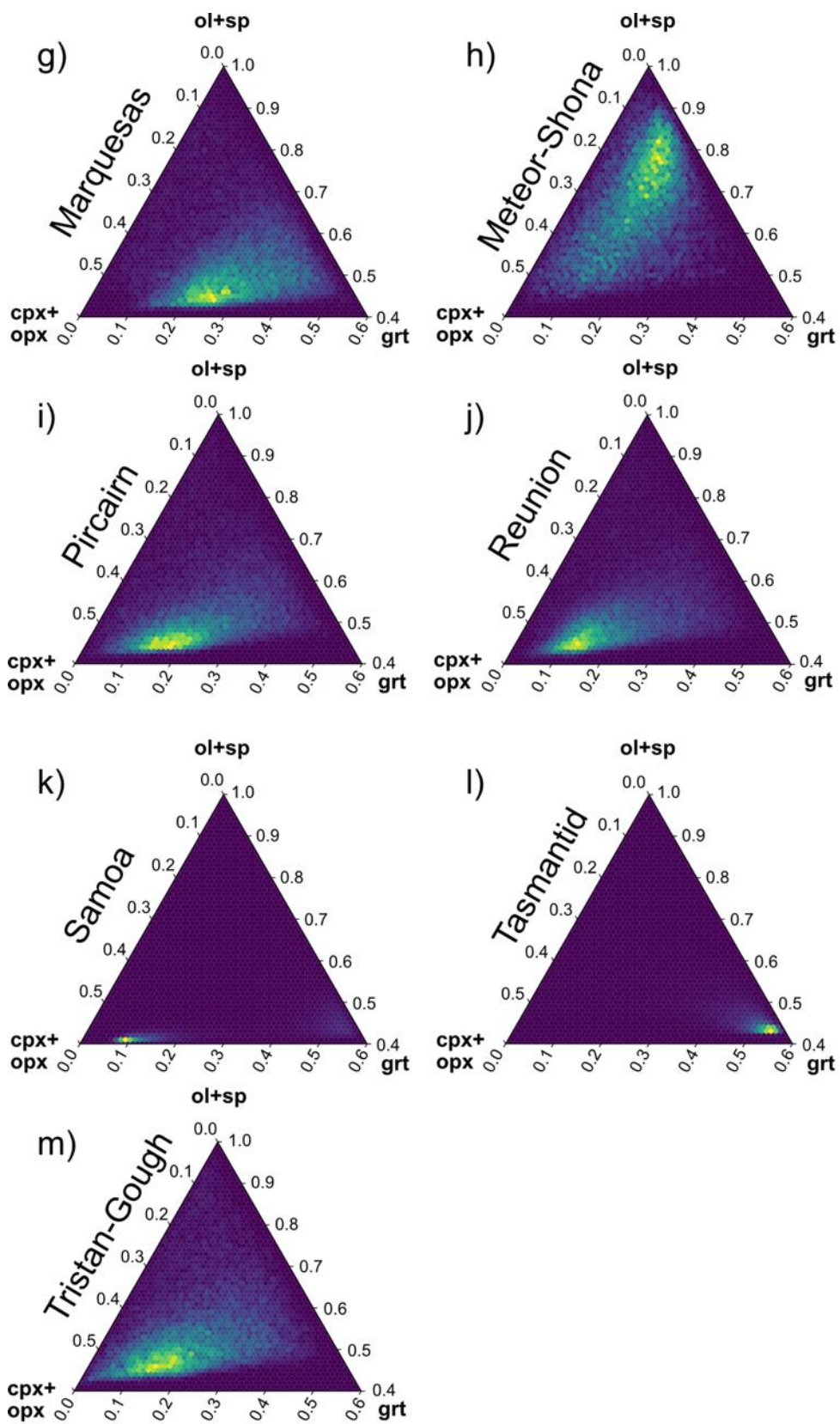


Figure S2 (cont.)

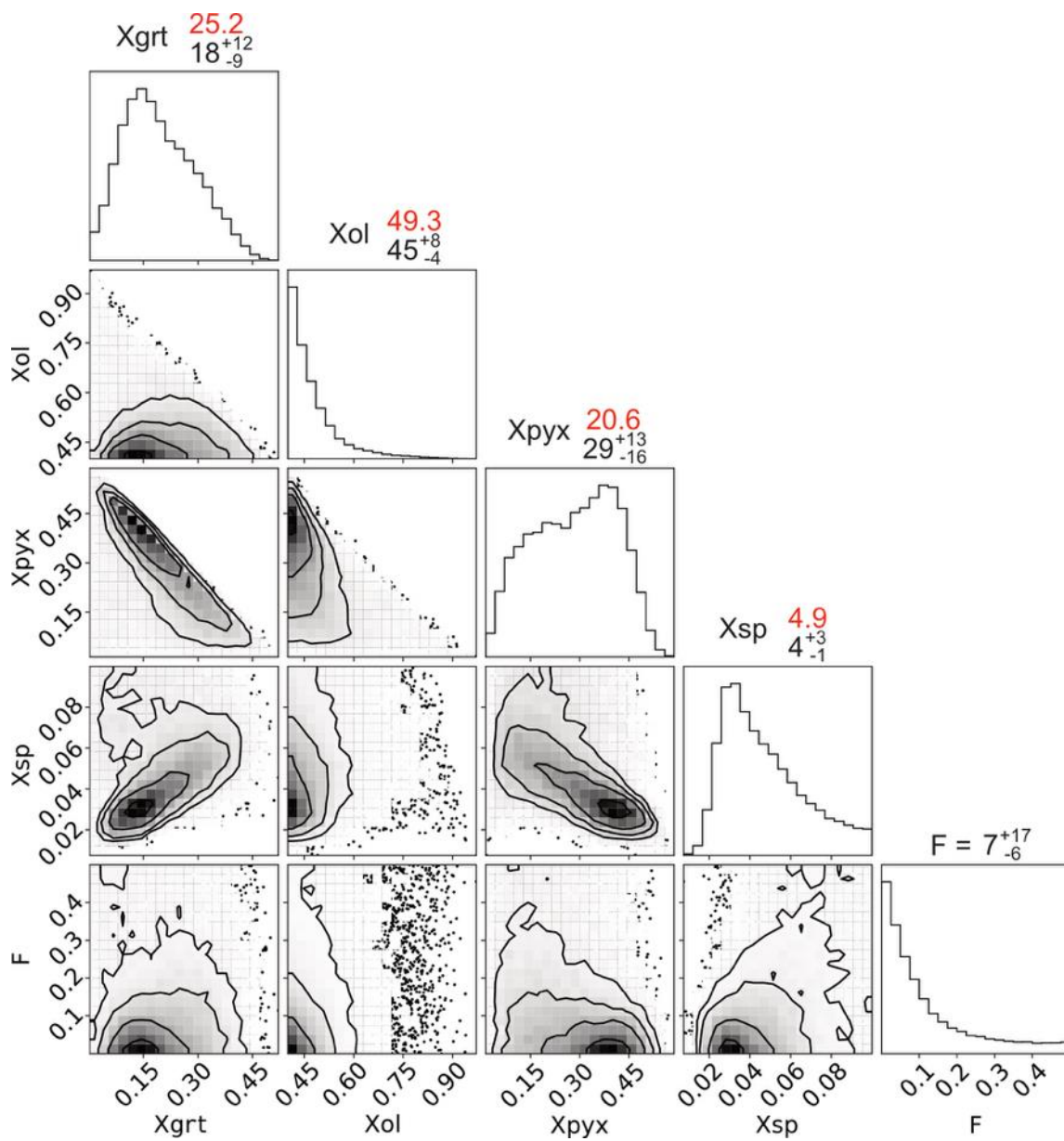


Figure S3. Corner plot for Azores

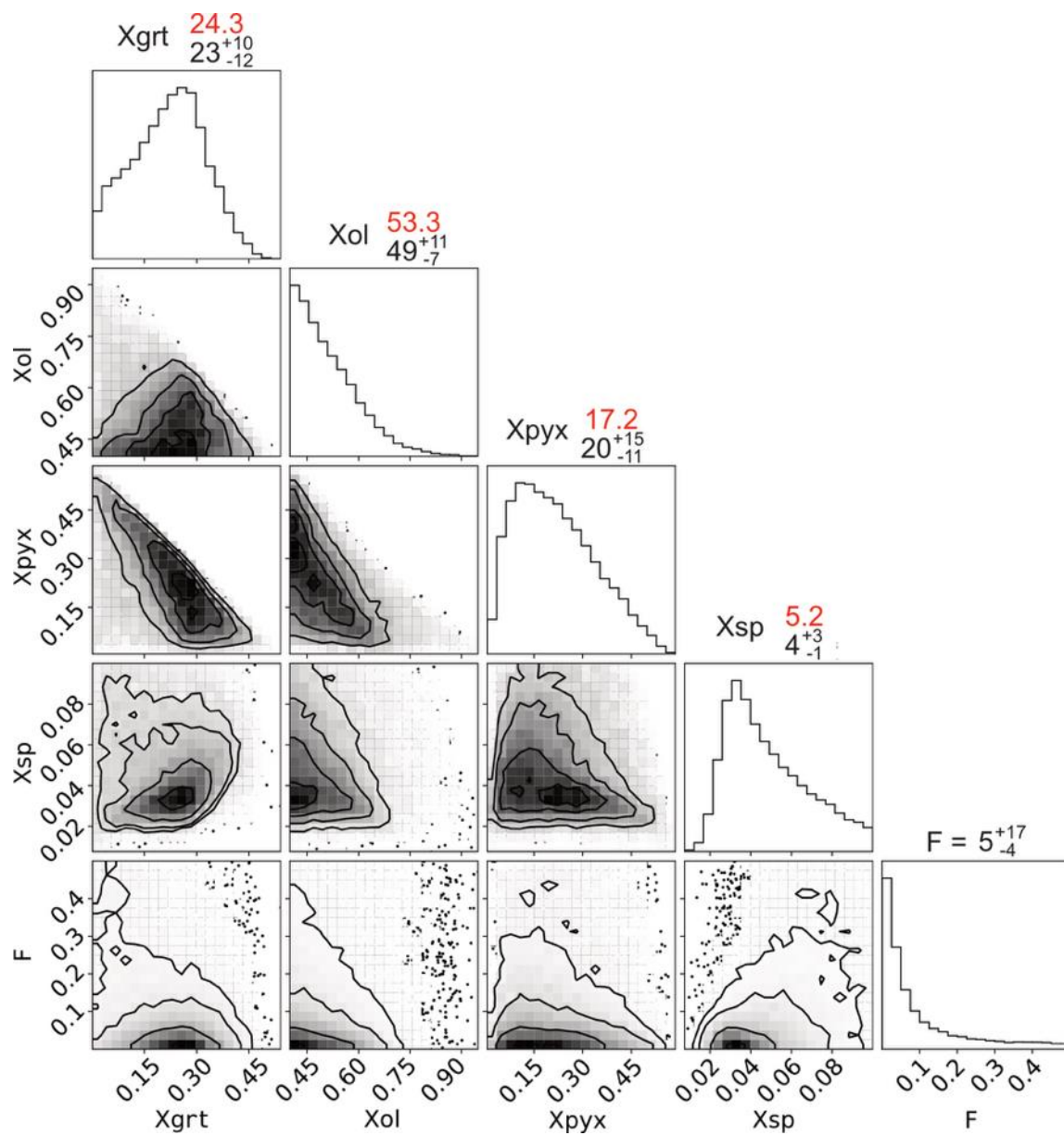


Figure S4. Corner plot for Bermuda

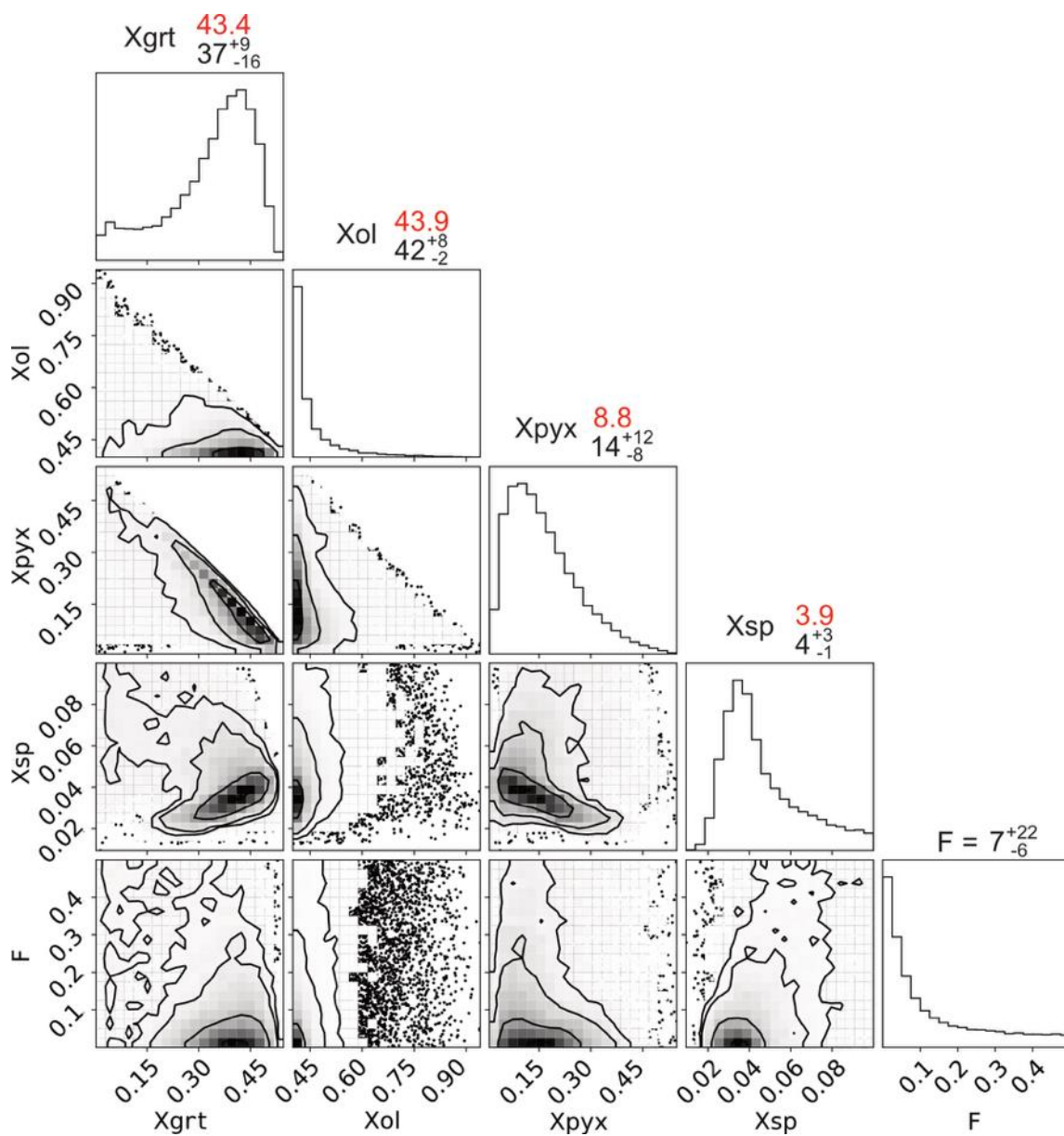


Figure S5. Corner plot for Canary

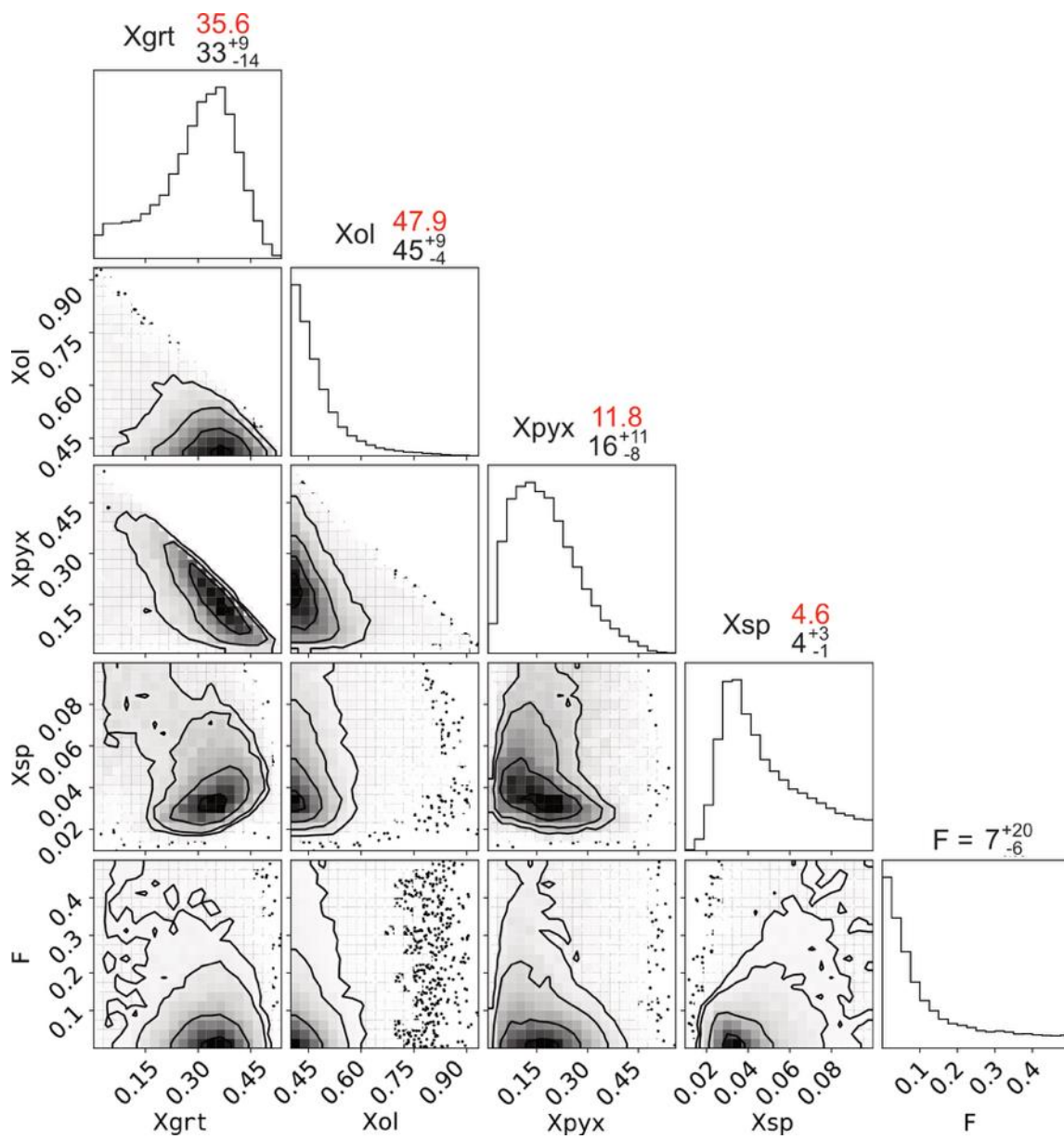


Figure S6. Corner plot for Cape Verde

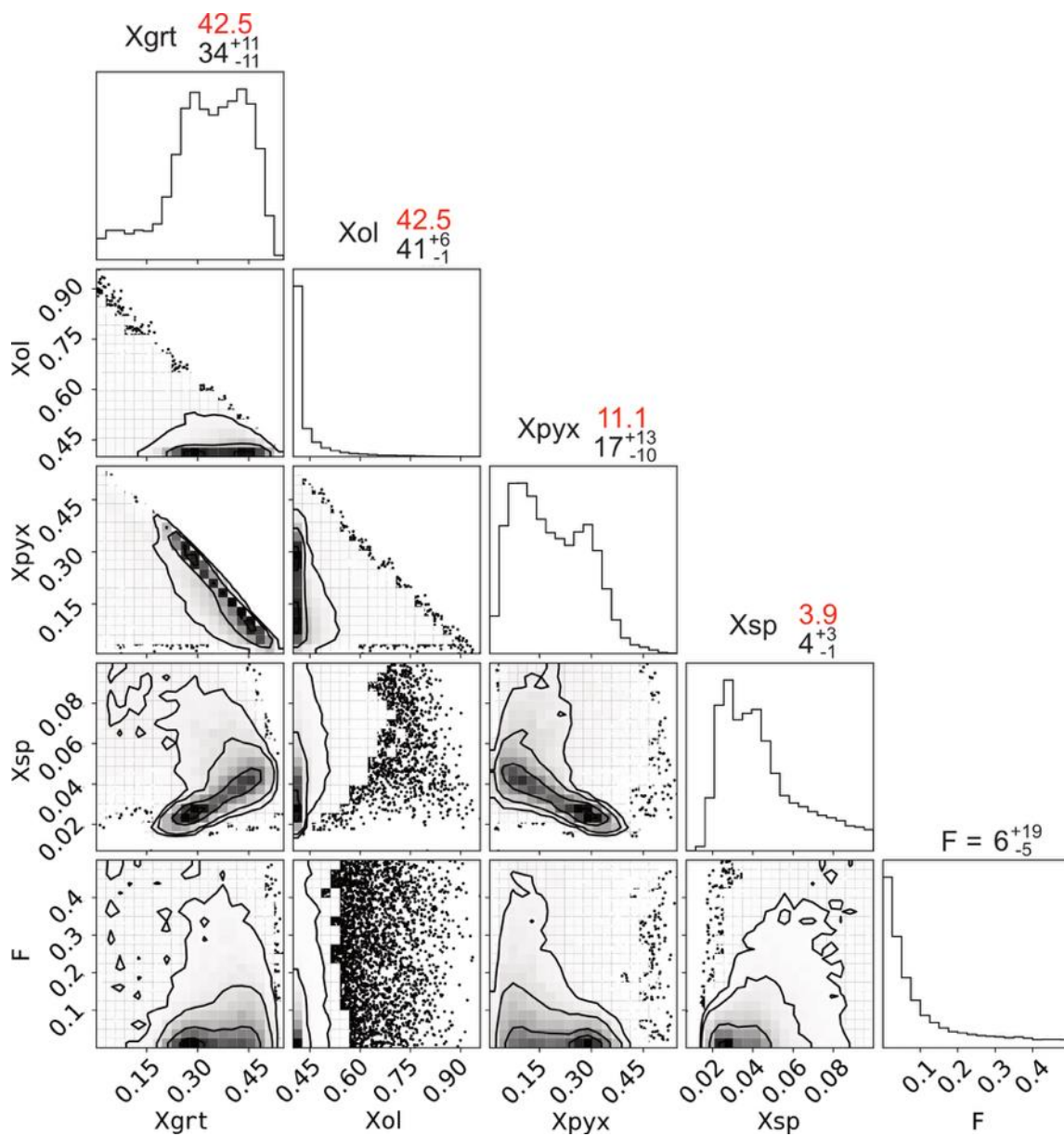


Figure S7. Corner plot for Caroline

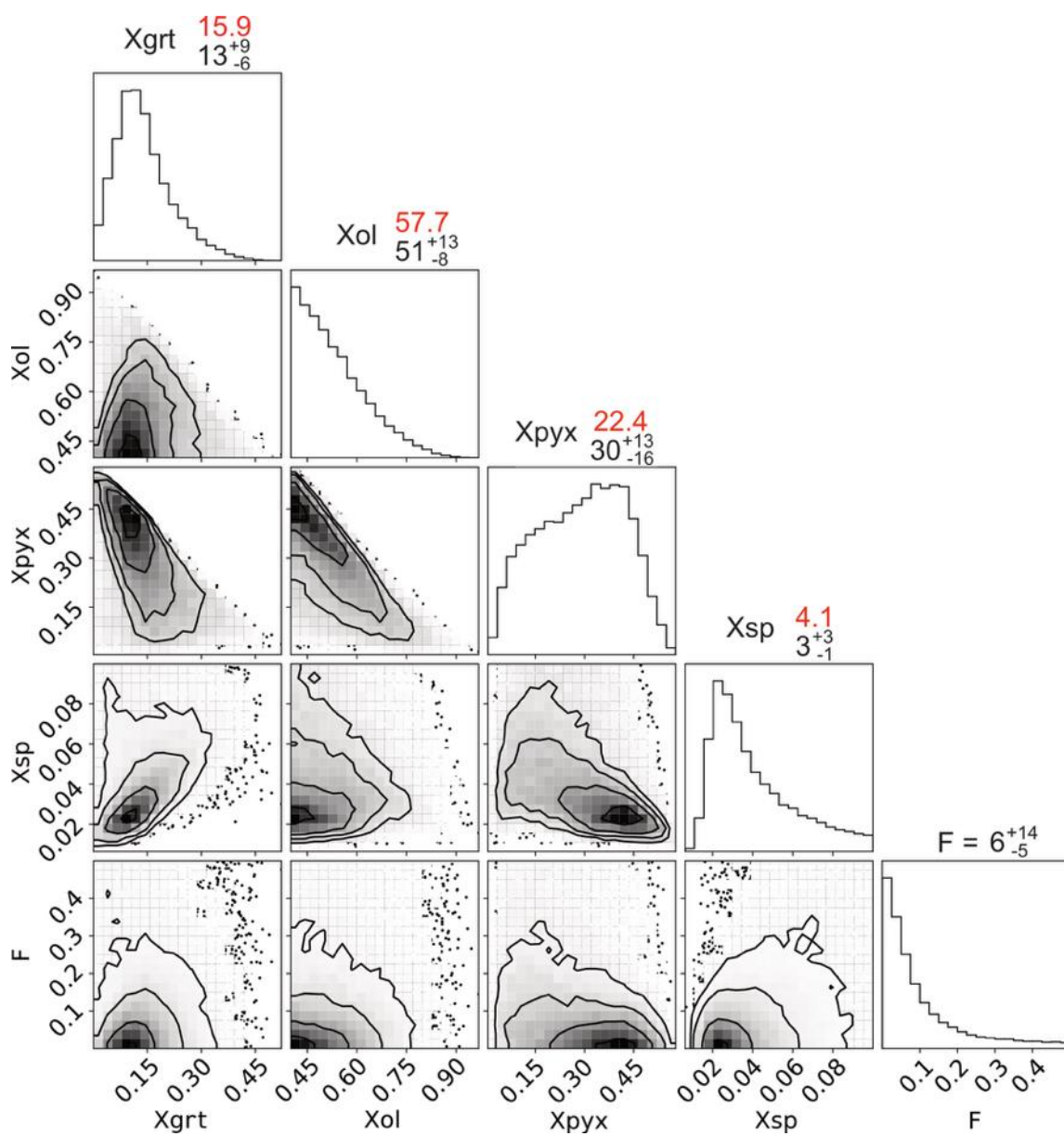


Figure S8. Corner plot for Easter

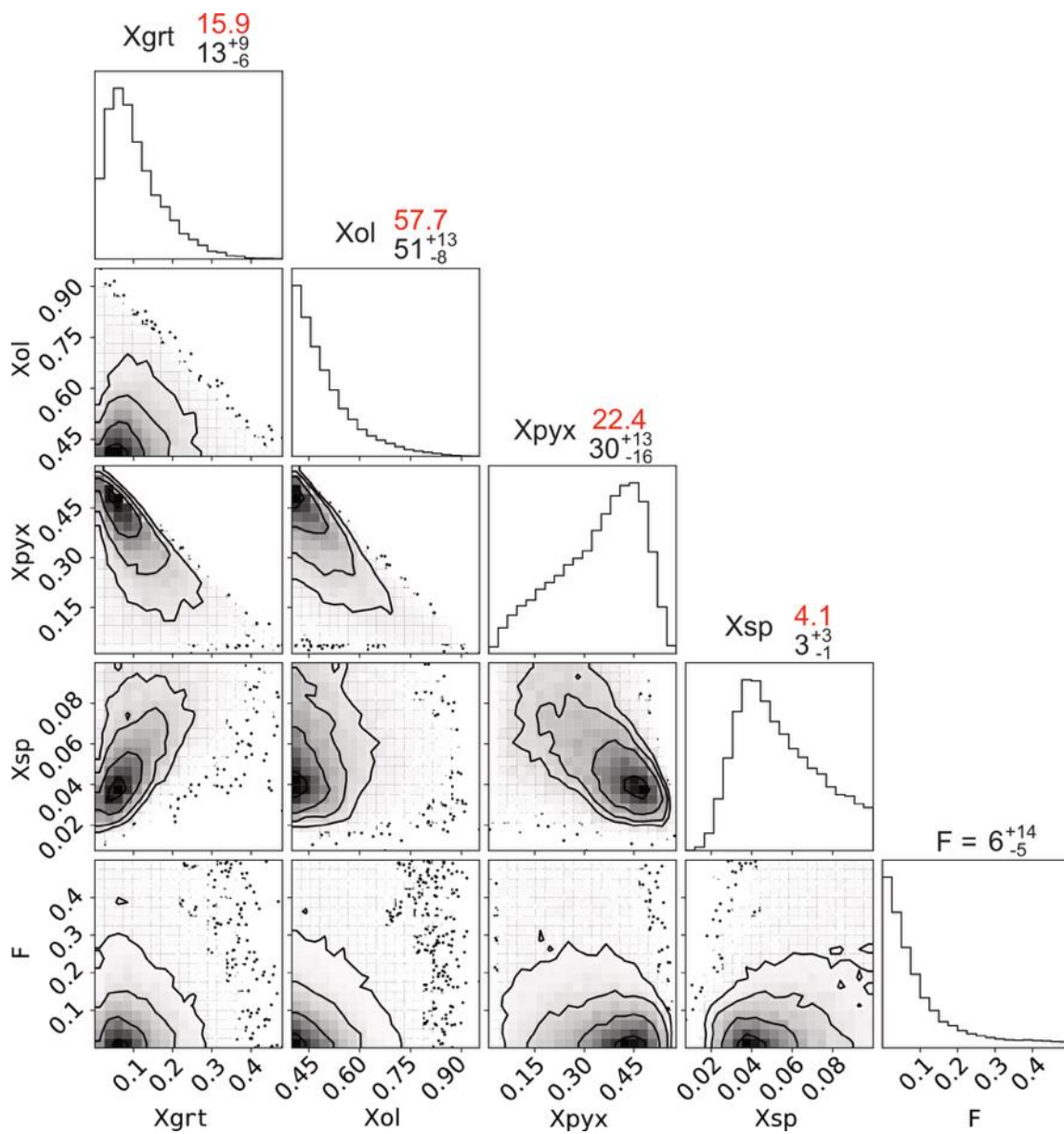


Figure S9. Corner plot for Galapagos

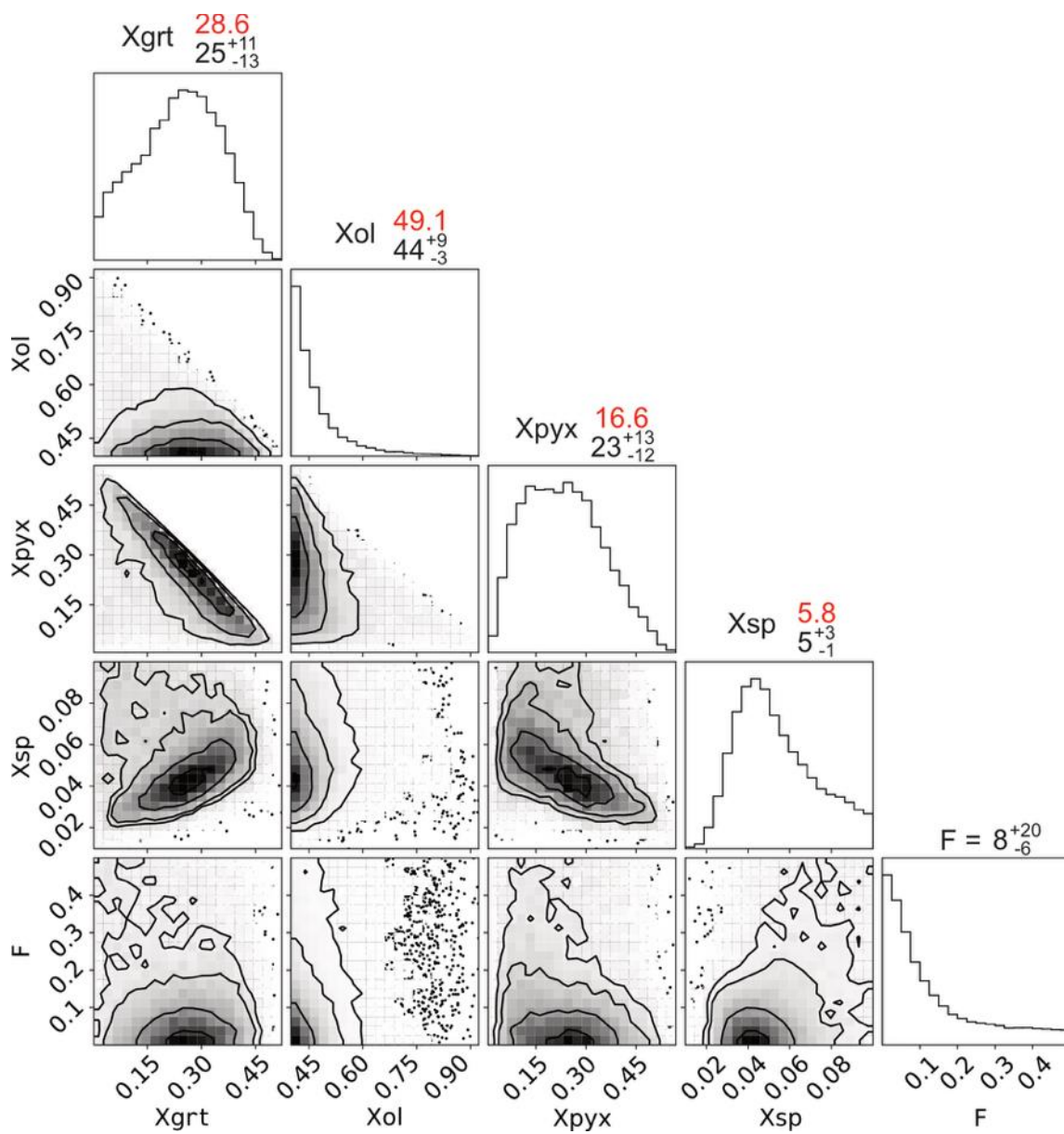


Figure S10. Corner plot for Hawaii

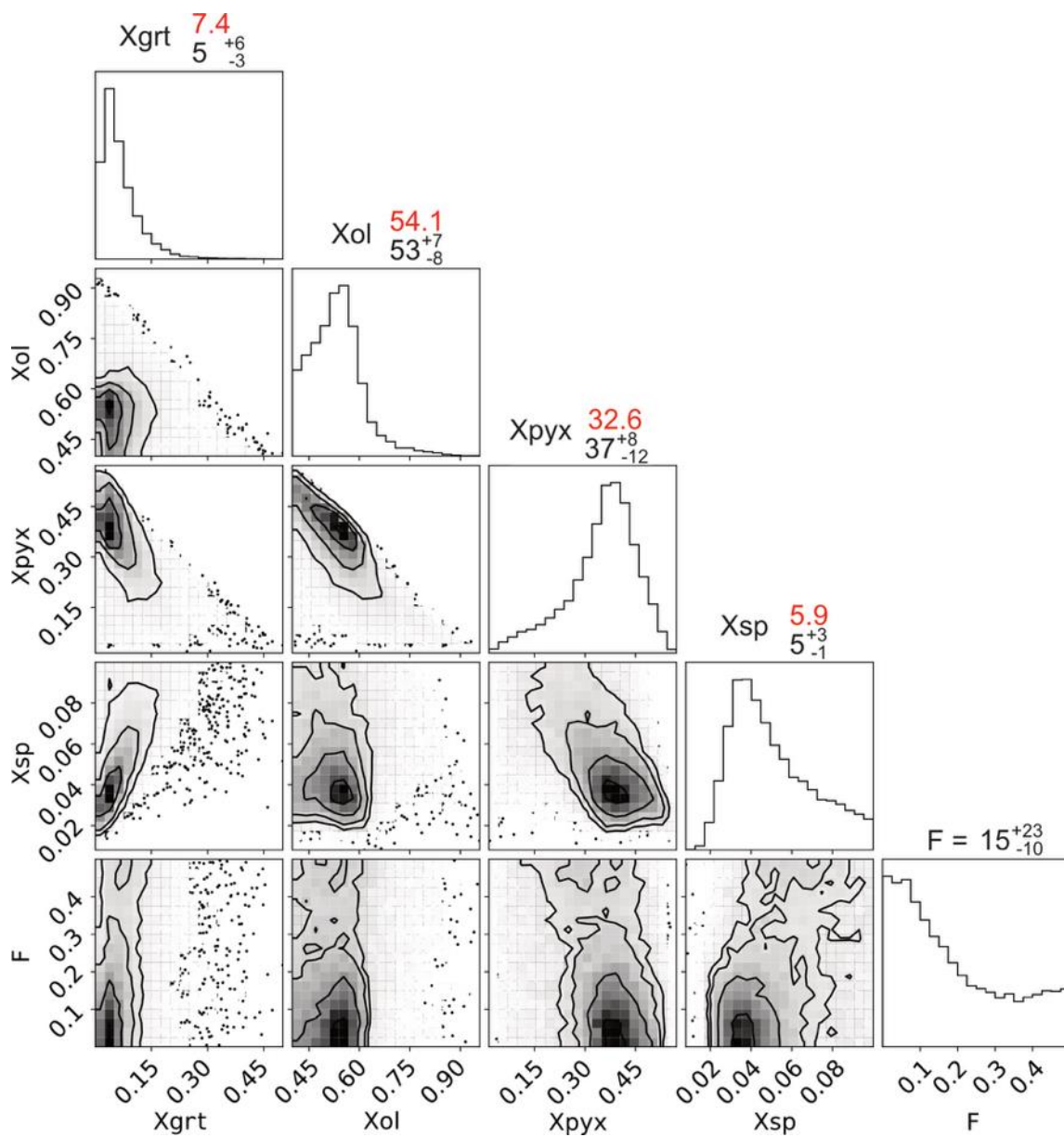


Figure S11. Corner plot for Iceland – Older Reykjanes Peninsula lavas

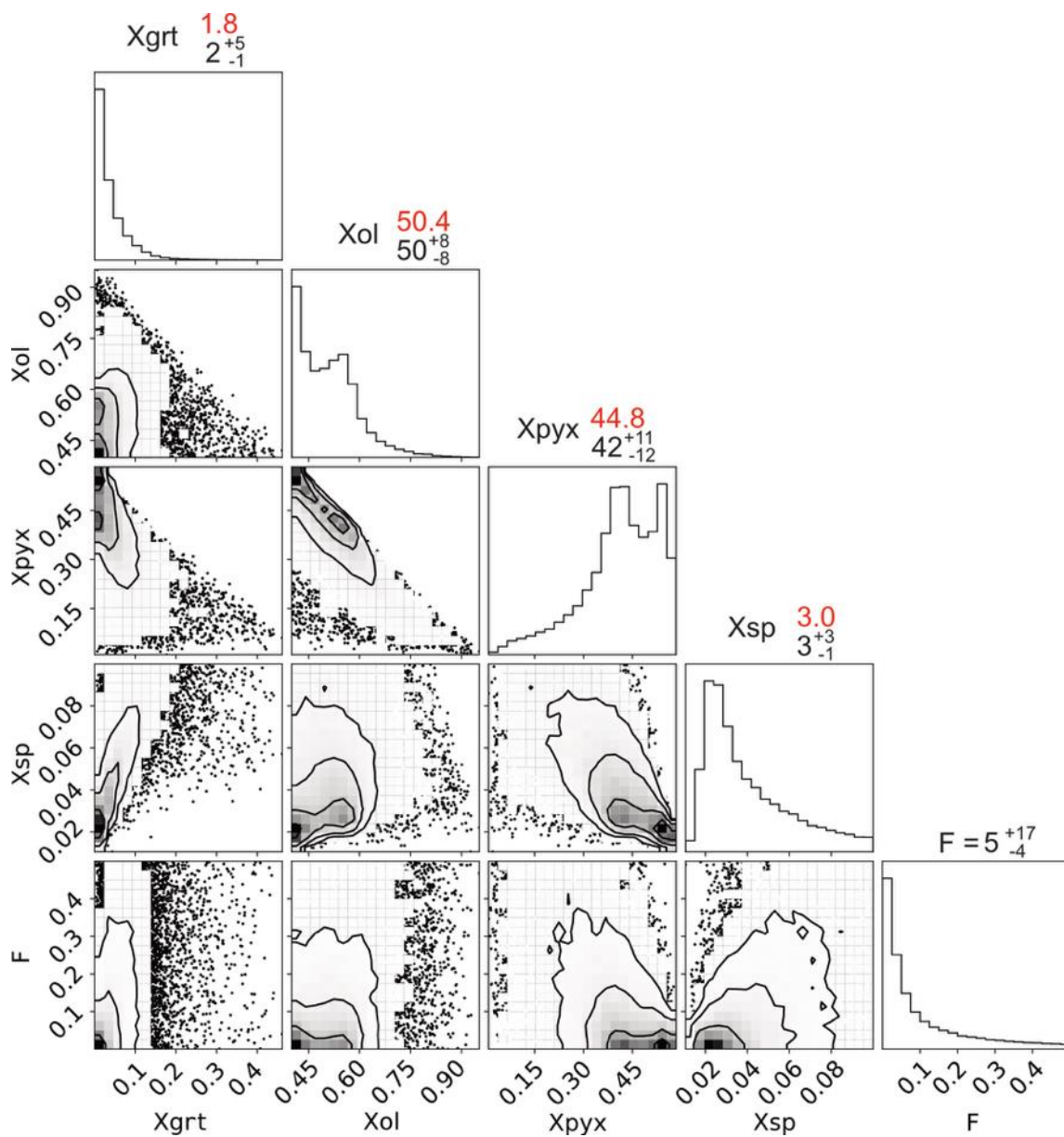


Figure S12. Corner plot for Iceland – Geldingadalir eruption

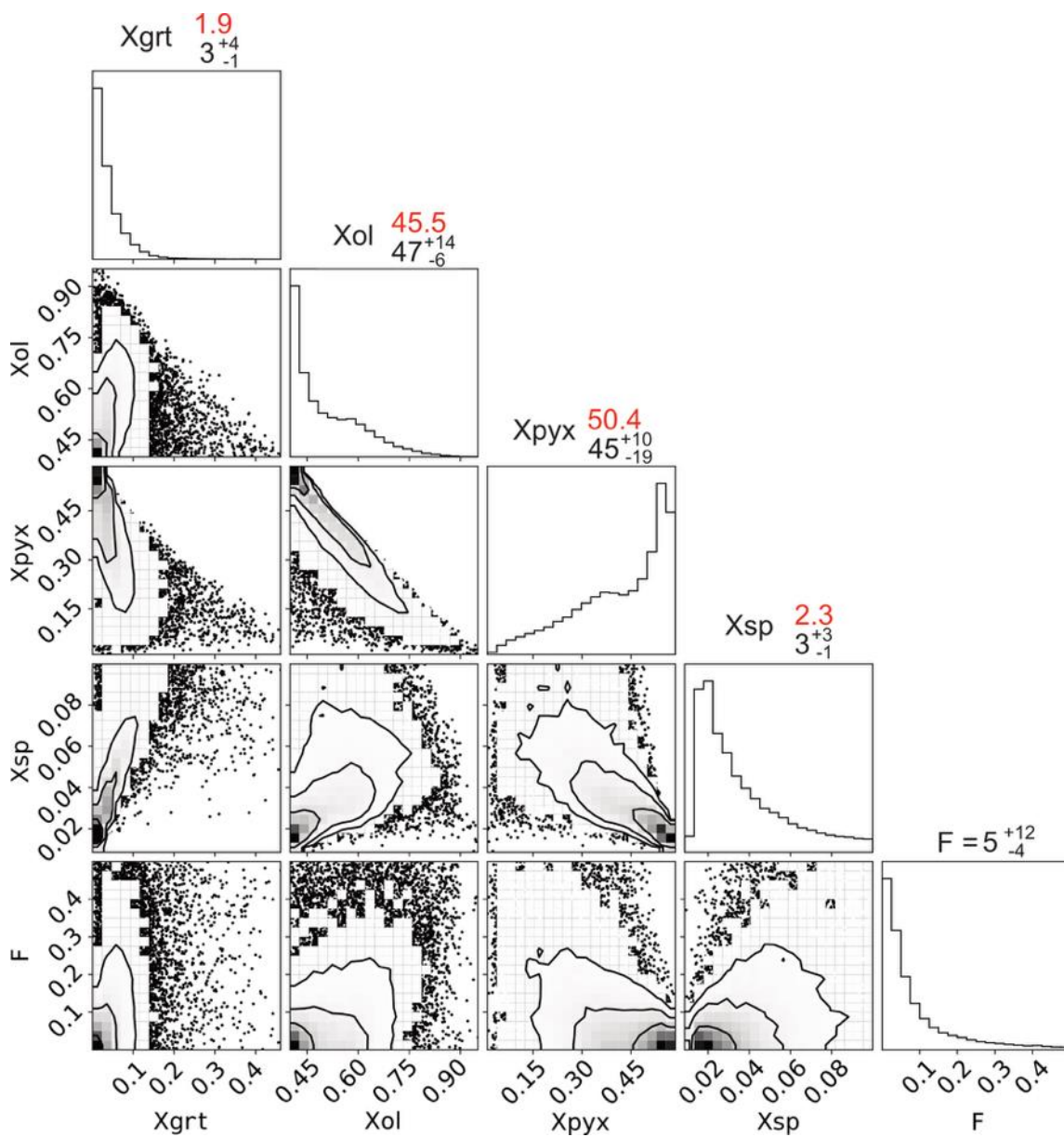


Figure S13. Corner plot for Iceland – Merdalir eruption

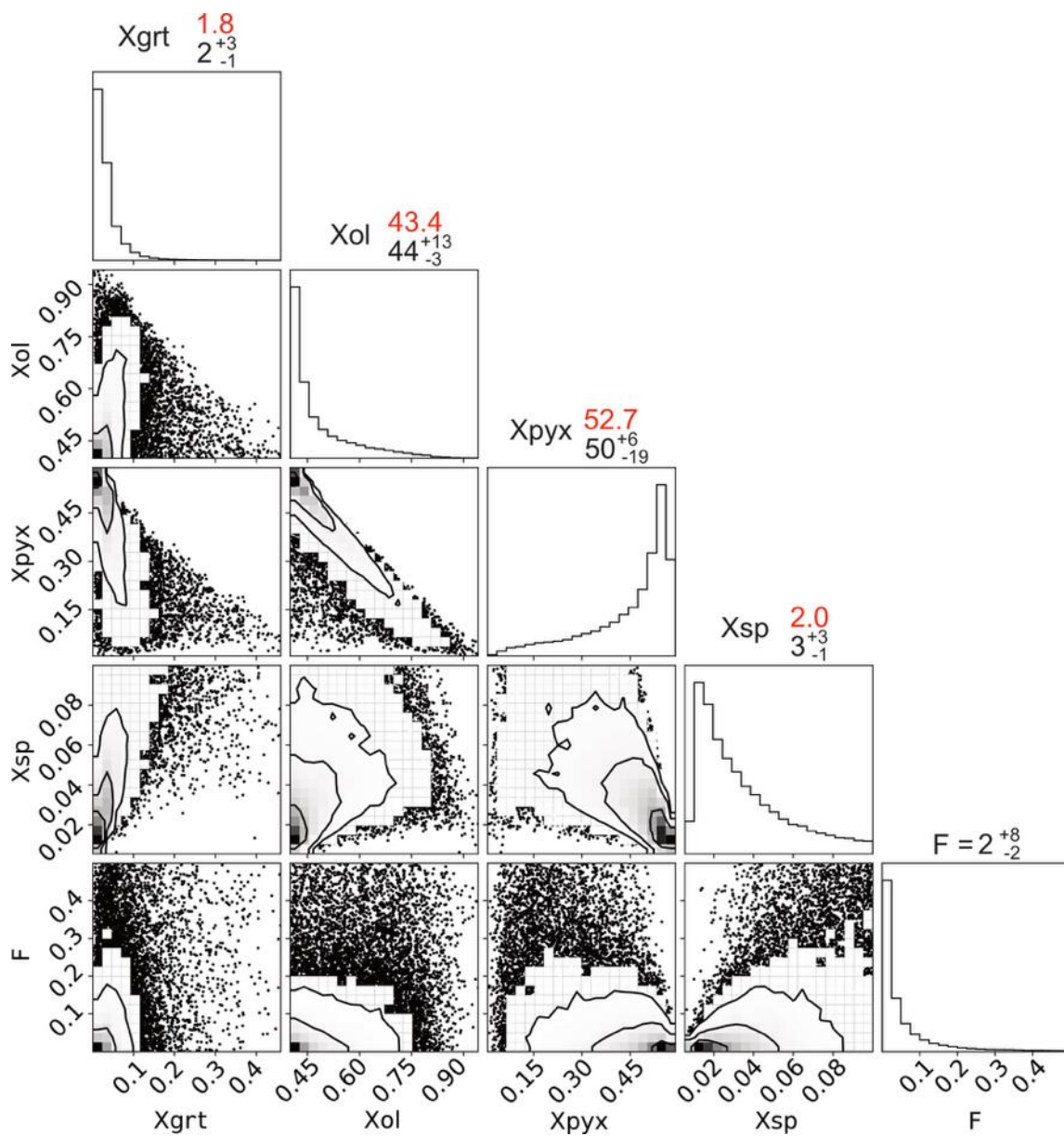


Figure S14. Corner plot for Iceland – Litli-Hrútur eruption

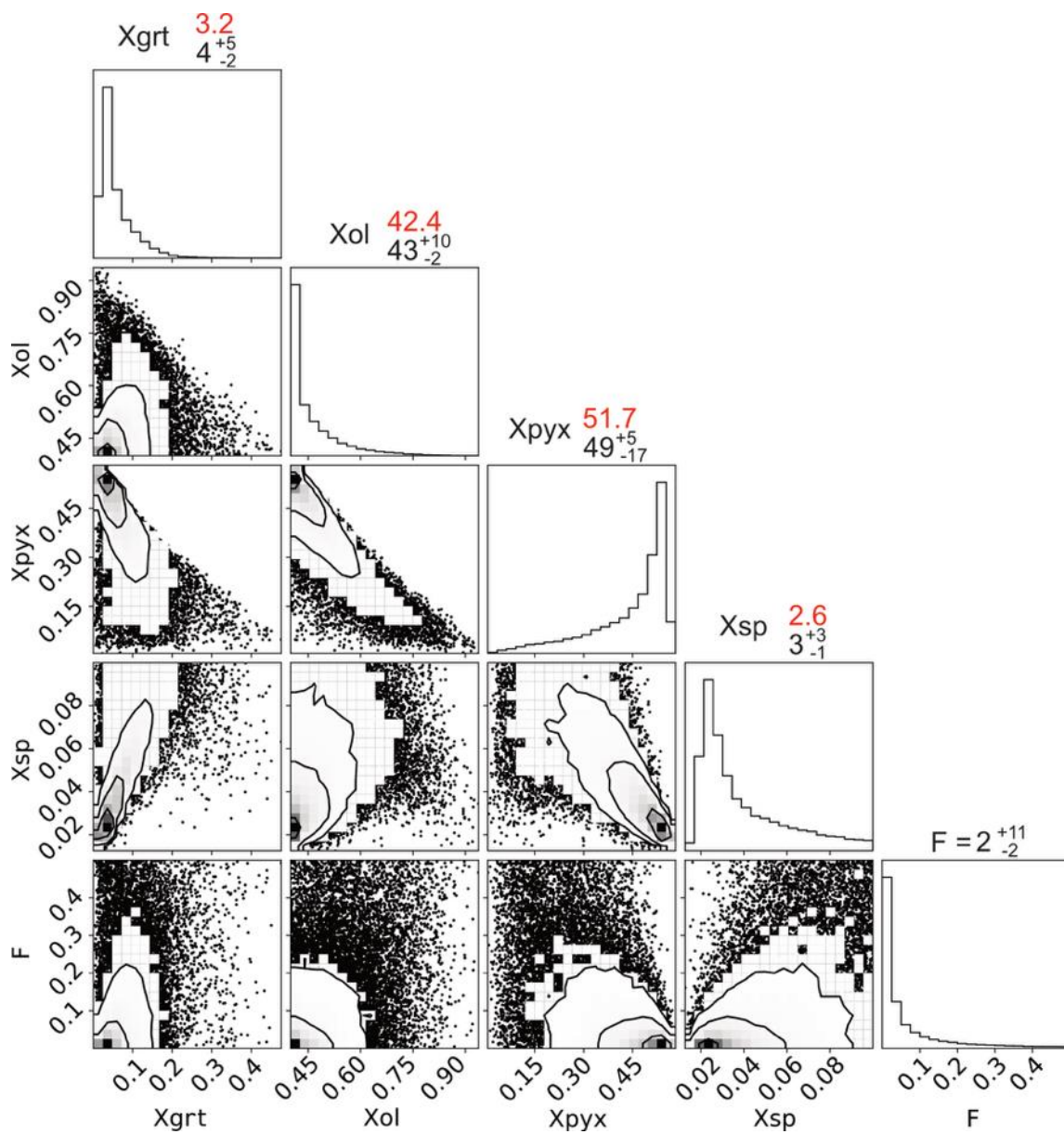


Figure S15. Corner plot for Iceland – Sundhnúksgrígar eruption

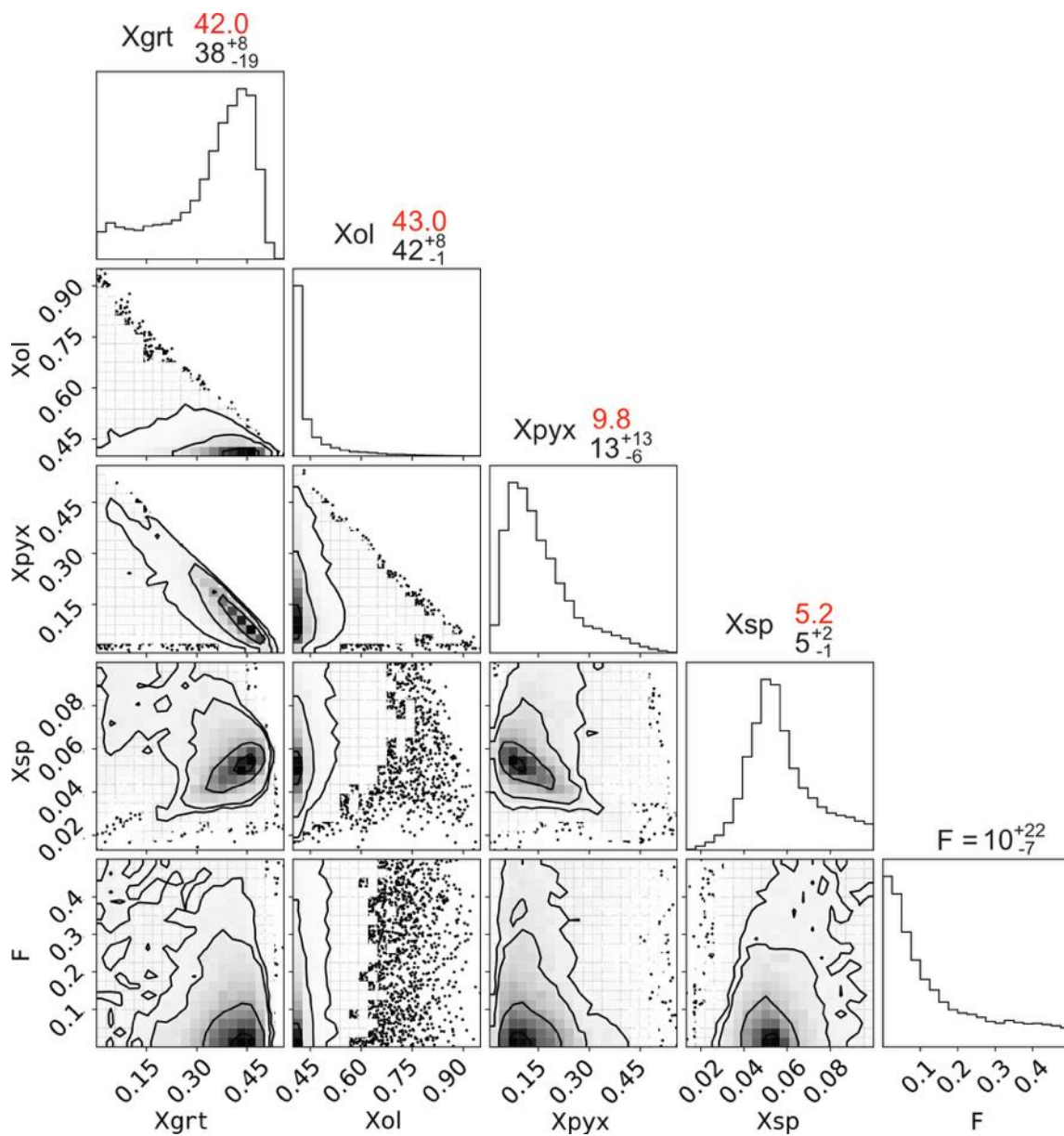


Figure S16. Corner plot for Macdonald

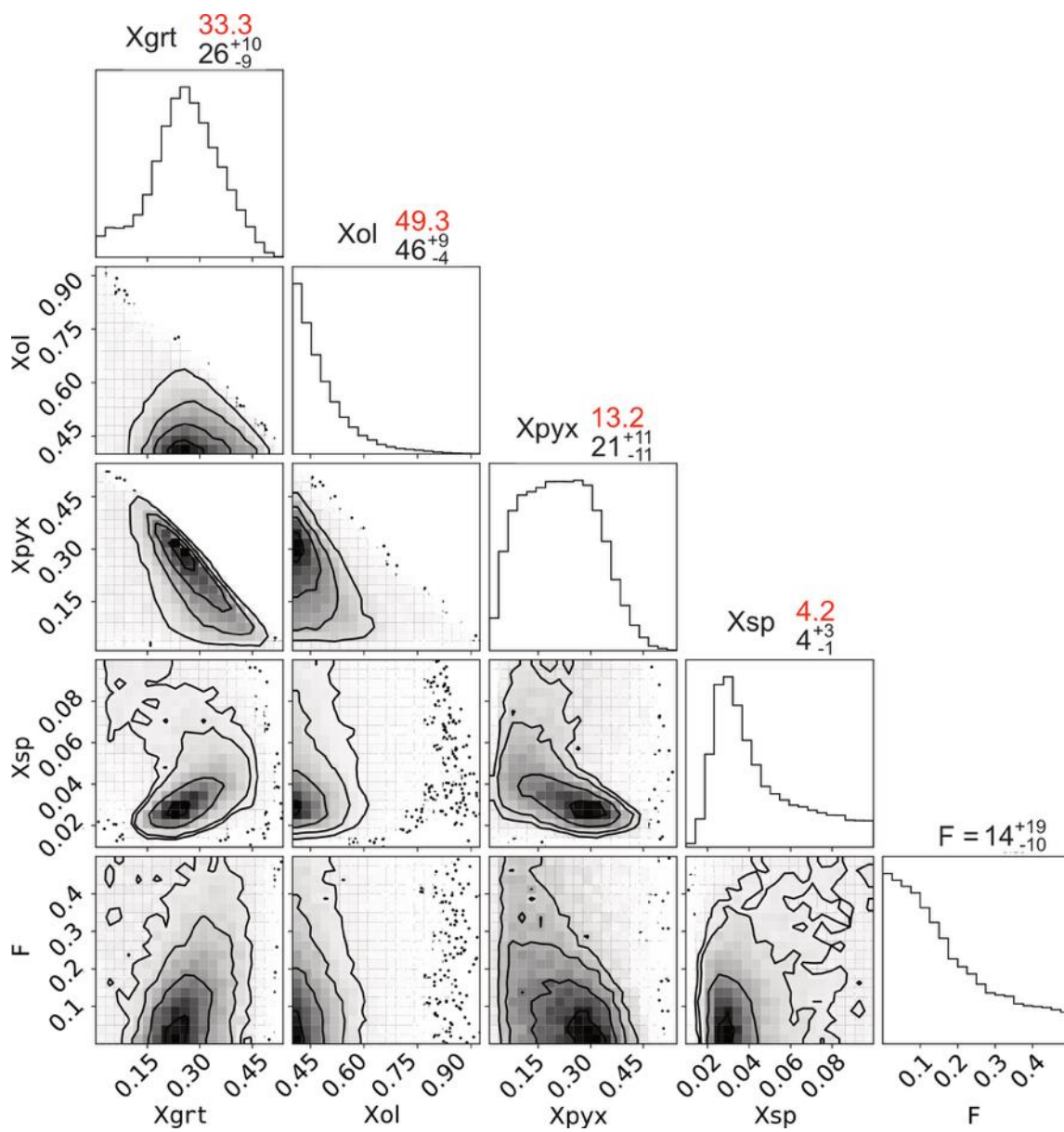


Figure S17. Corner plot for Marquesas

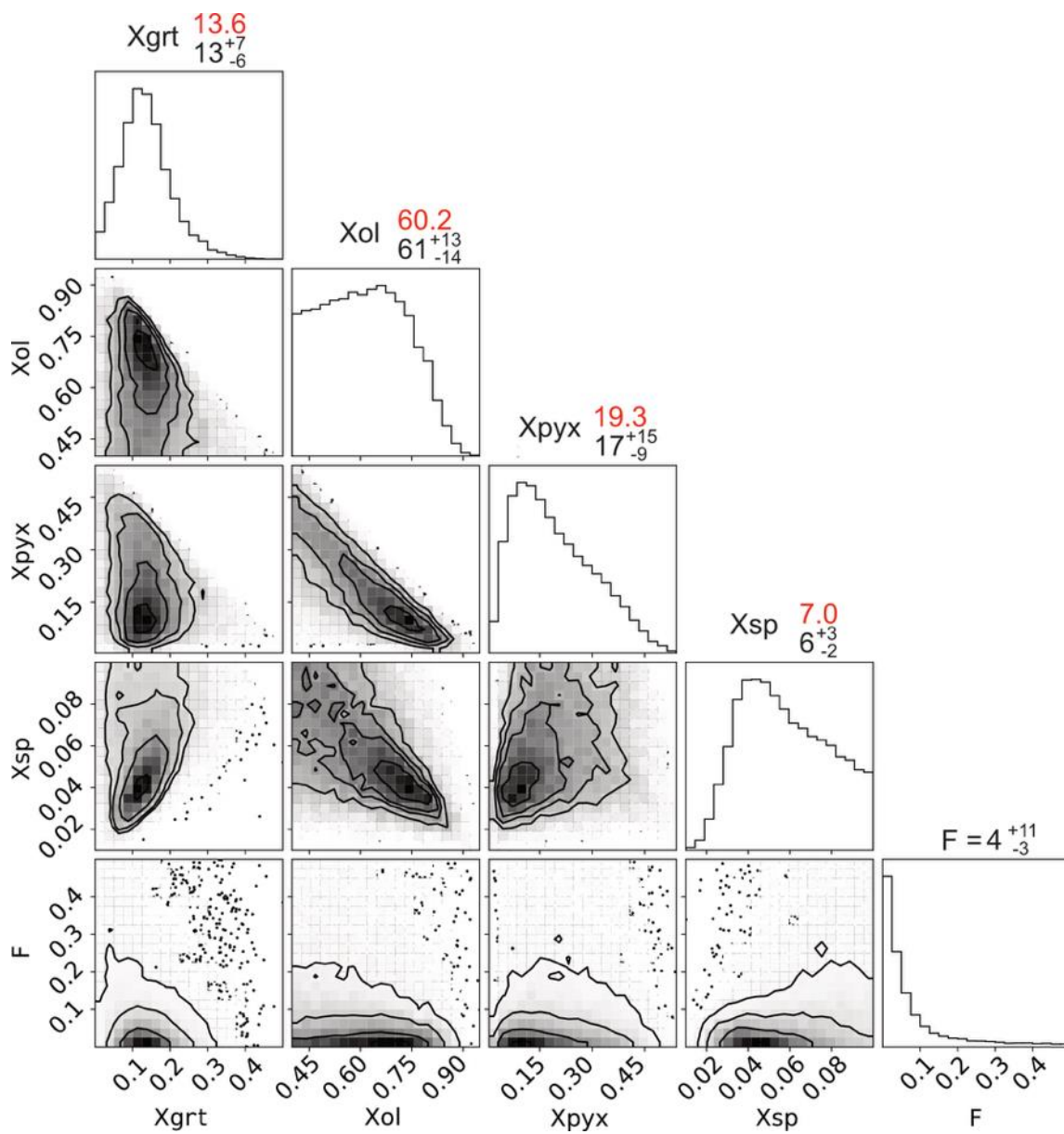


Figure S18. Corner plot for Meteor-Shona

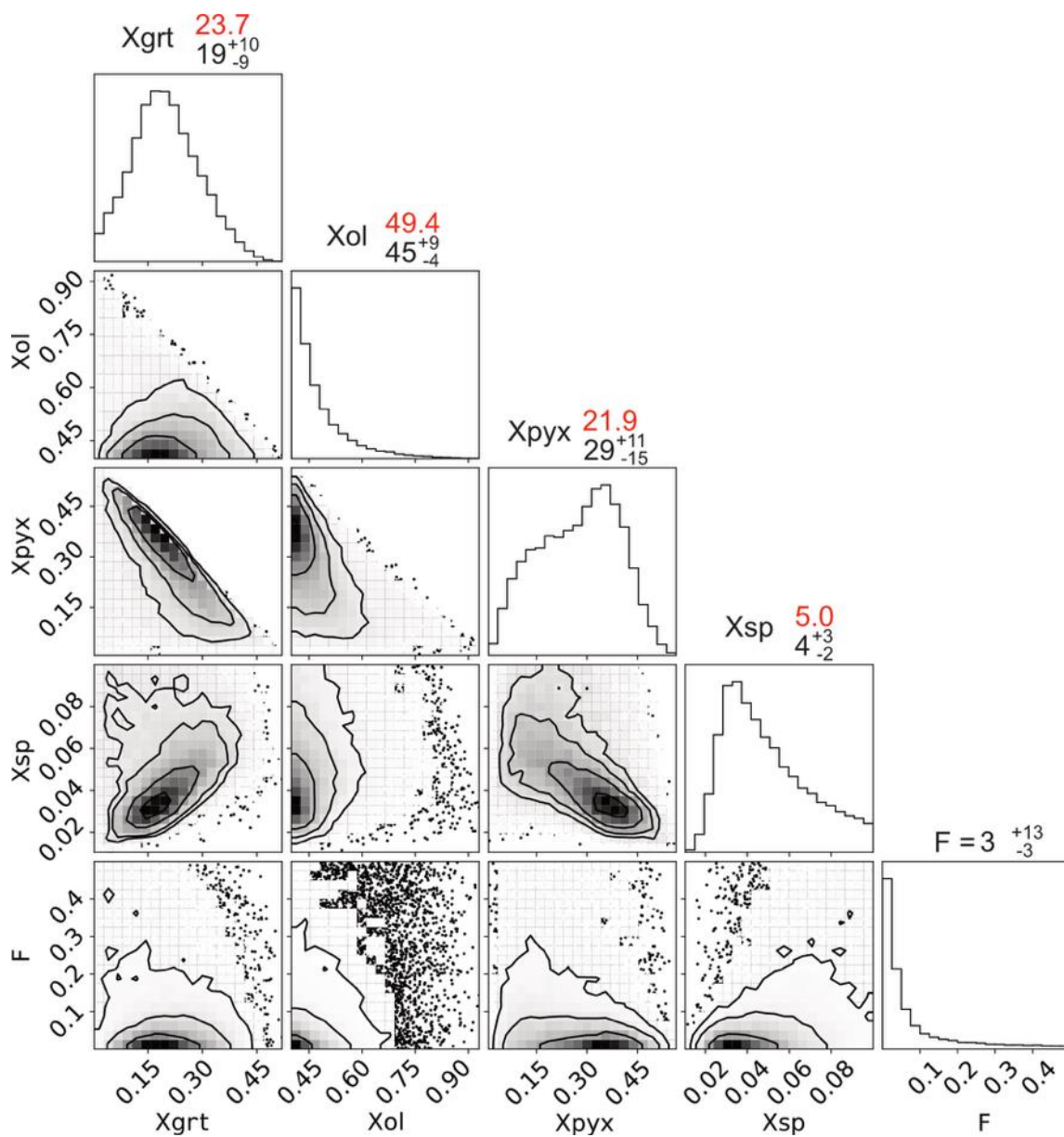


Figure S19. Corner plot for Pitcairn

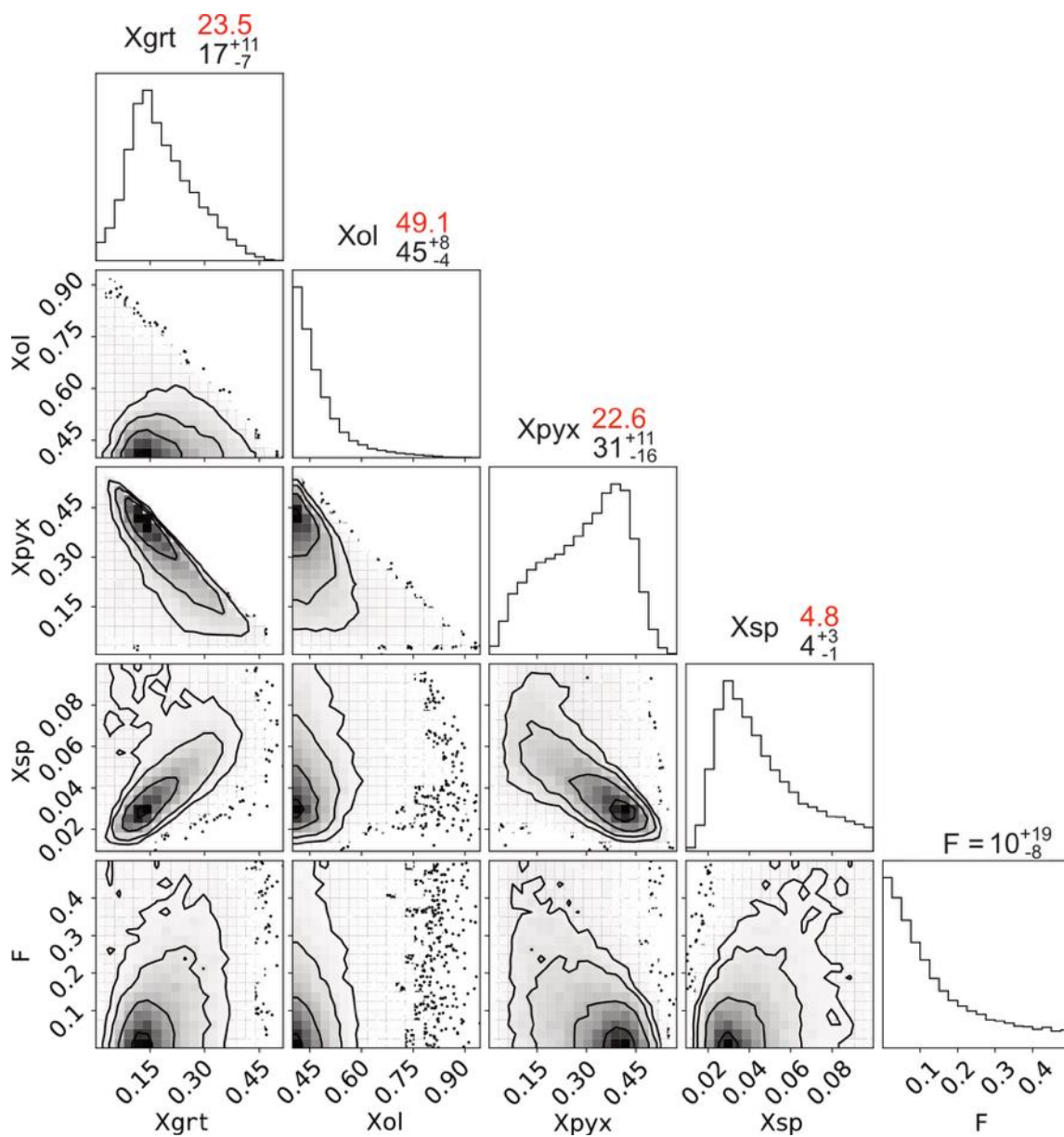


Figure S20. Corner plot for Reunion

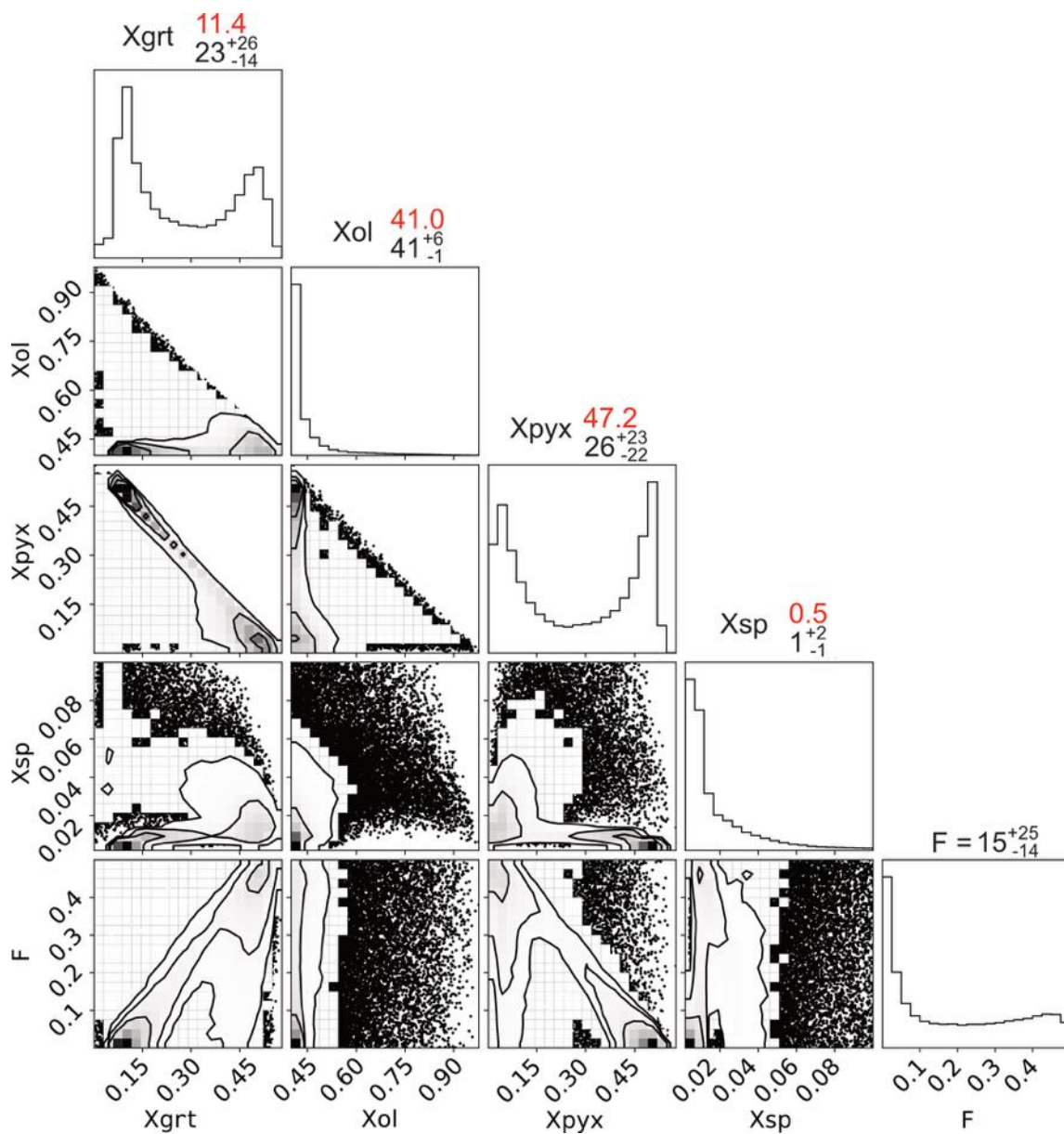


Figure S21. Corner plot for Samoa

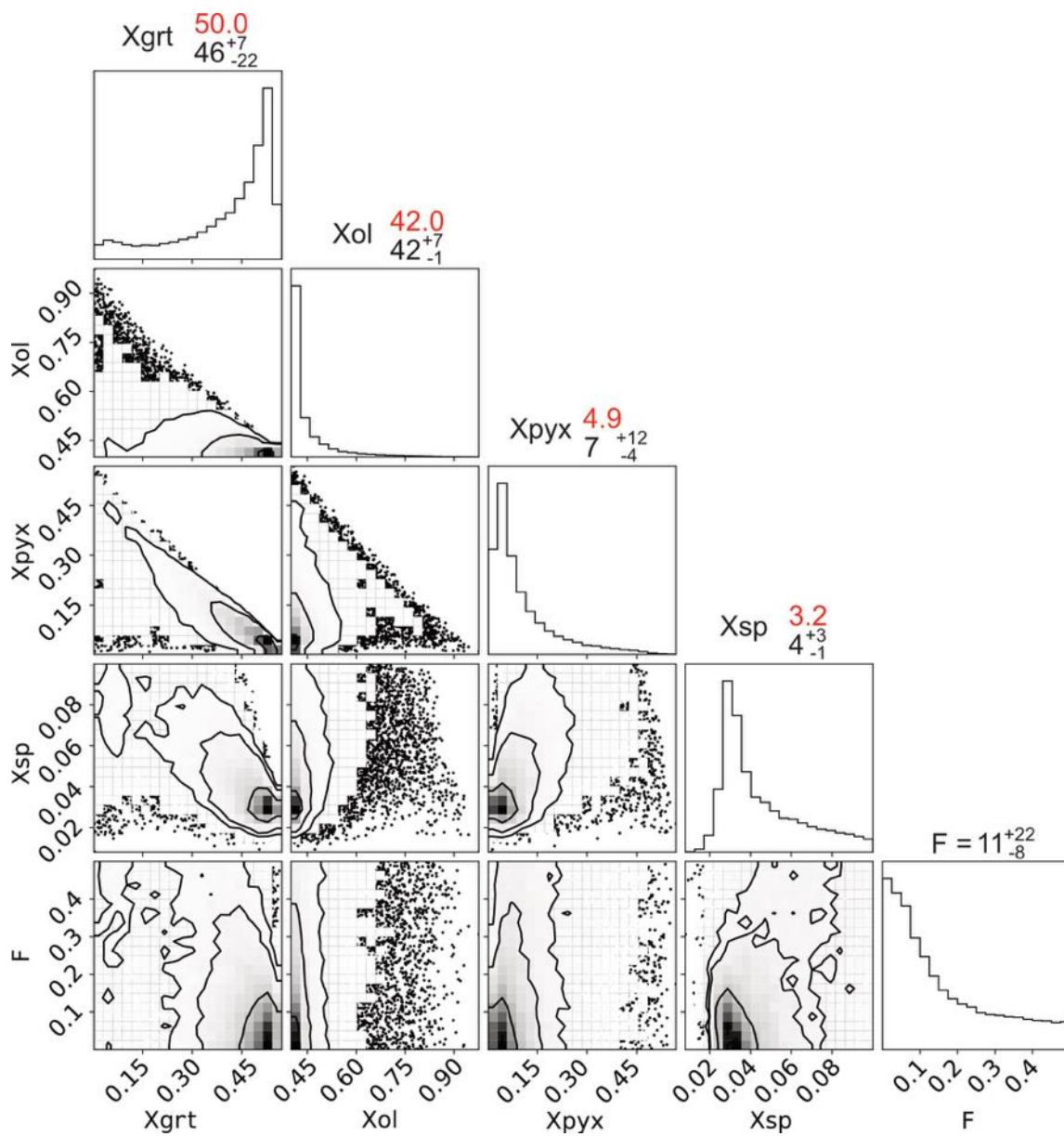


Figure S22. Corner plot for Tasmantid-Tasman Central

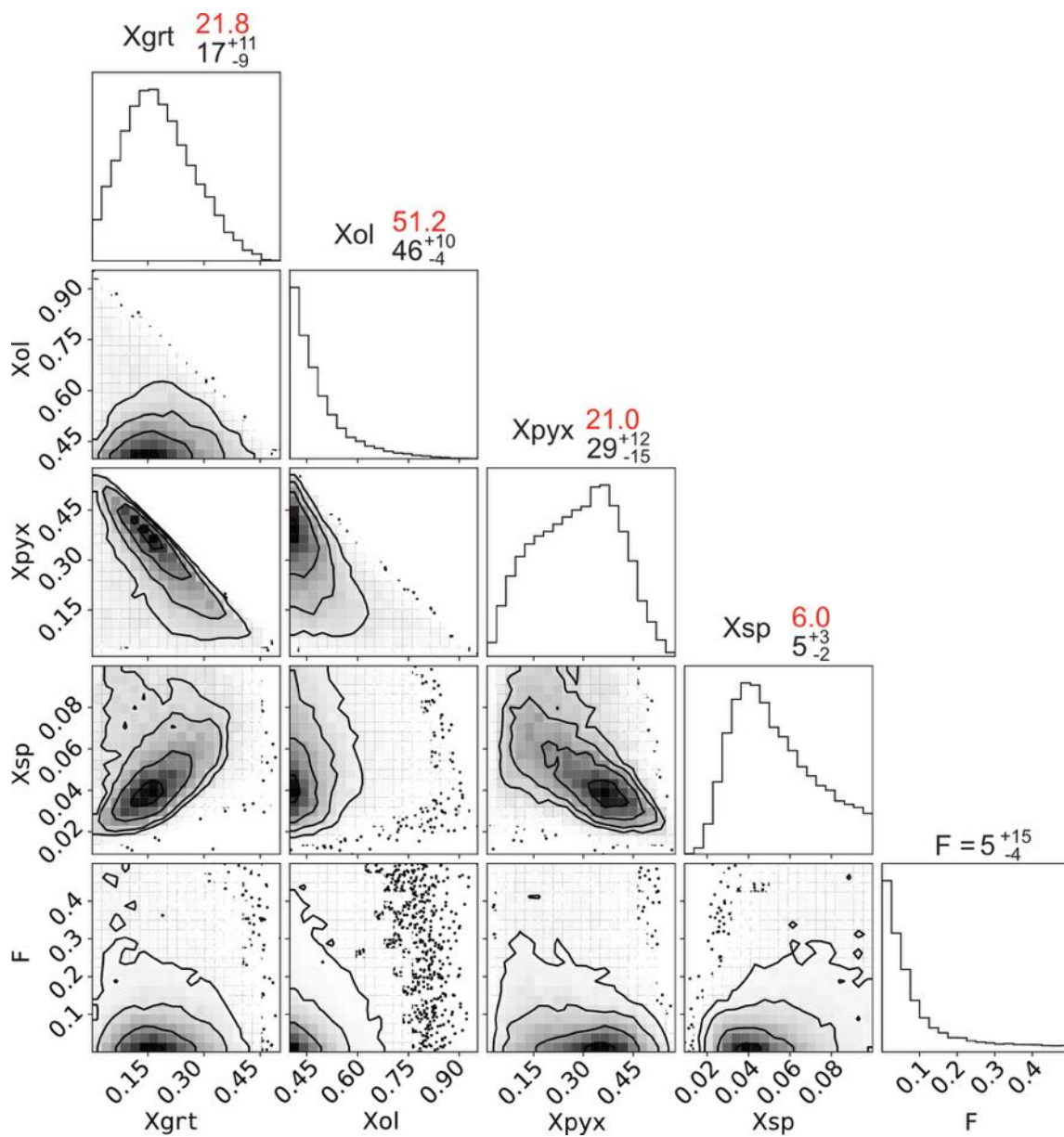


Figure S23. Corner plot for Tristan-Gough-Walvis Ridge

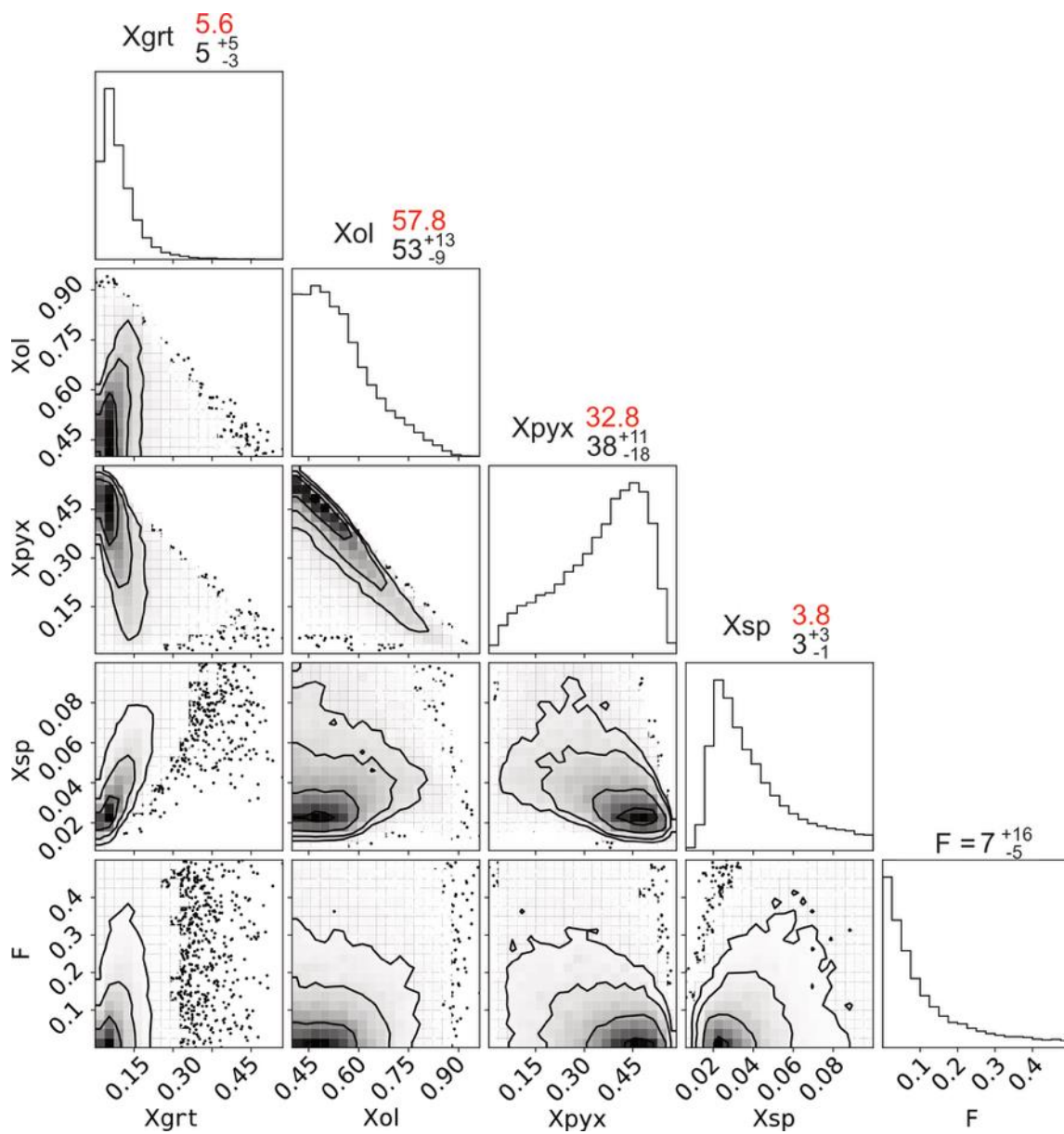


Figure S24. Corner plot for N-MORB

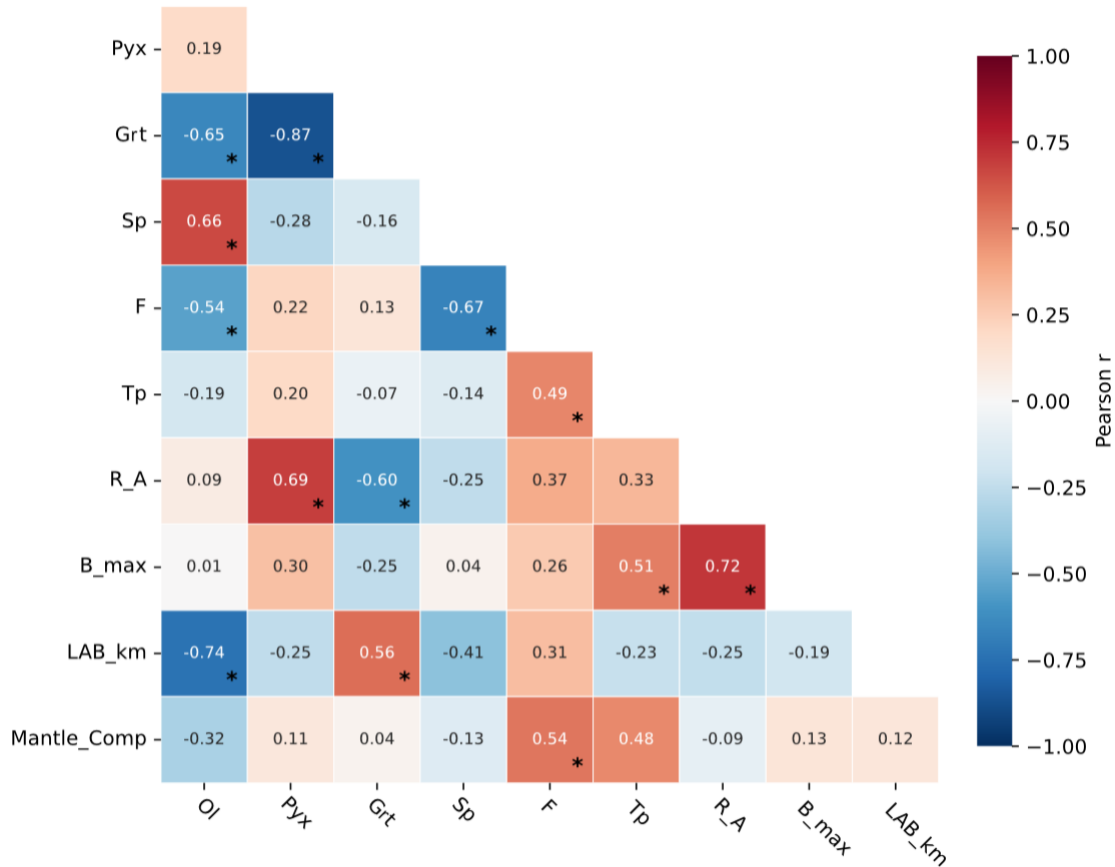


Figure S25. Pearson correlation matrix among modal mineralogy (olivine, pyroxene, garnet, spinel), degree of melting, mantle potential temperature, $^3\text{He}/^4\text{He}$, buoyancy flux, lithosphere–asthenosphere boundary (LAB) depth, and mantle compositional end member across $n = 17$ OIB localities. Cell values are Pearson's r ; correlations are computed using pairwise-complete observations, so sample size varies slightly among variable pairs where $^3\text{He}/^4\text{He}$ or LAB depth were not reported (see Table 1). Asterisks denote significant correlations at $p < 0.05$. Mantle compositional end members are categorical variables (coded PREMA = 1, DM = 2, EMI = 3, EMII = 4, HIMU = 5, LOND = 6) included here as ordinal for comparison with the continuous variables; their correlations should be interpreted with this in mind. See Table 1 for full list of references.

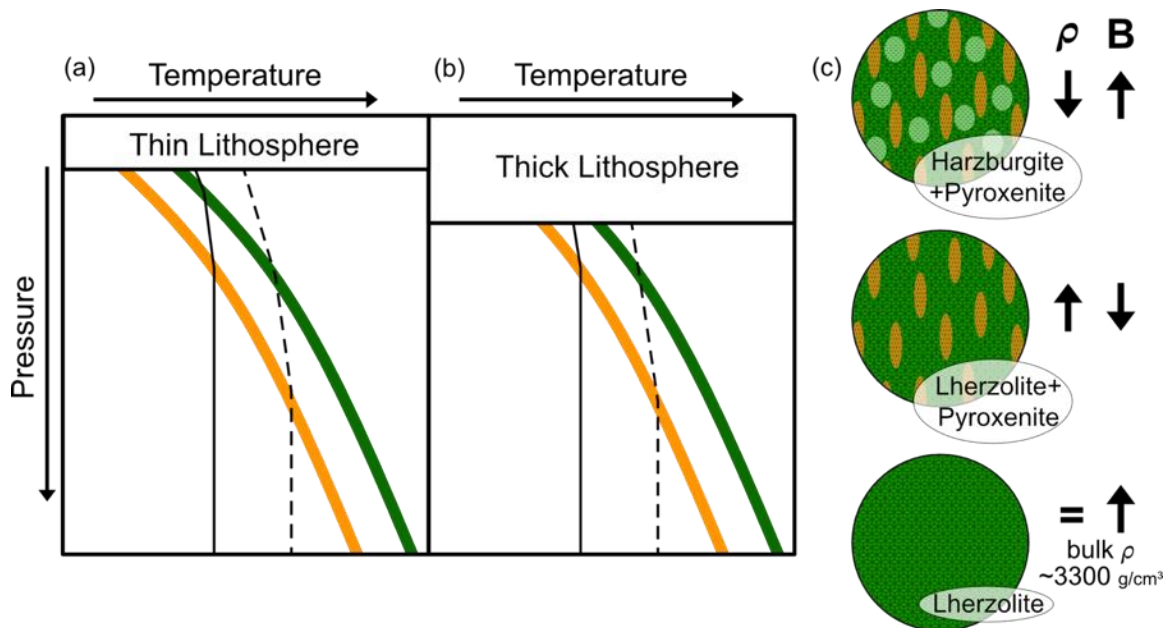


Figure S26. The effect of LAB, T_p and refractory material on the contribution of ol-poor (i.e., pyroxenitic) lithology to the melt. Panels (a) and (b) depict the peridotite (green) and pyroxenite (orange) solidi under thinner and thicker lithosphere, respectively. The vertical lines represent solid adiabats under two temperature conditions, demonstrating that the region under which melting occurs (i.e., the melting column) is longest at higher temperature under a thin lithosphere. Under thicker lithosphere, the top of the melting column is truncated, leading to an over-sampling of the more fusible lithology. (c) represents the control that bulk density (ρ) has on buoyancy (B), where the high density of pyroxenitic lithologies must be compensated by a lower density matrix, such as harzburgite, to maintain active upwelling.

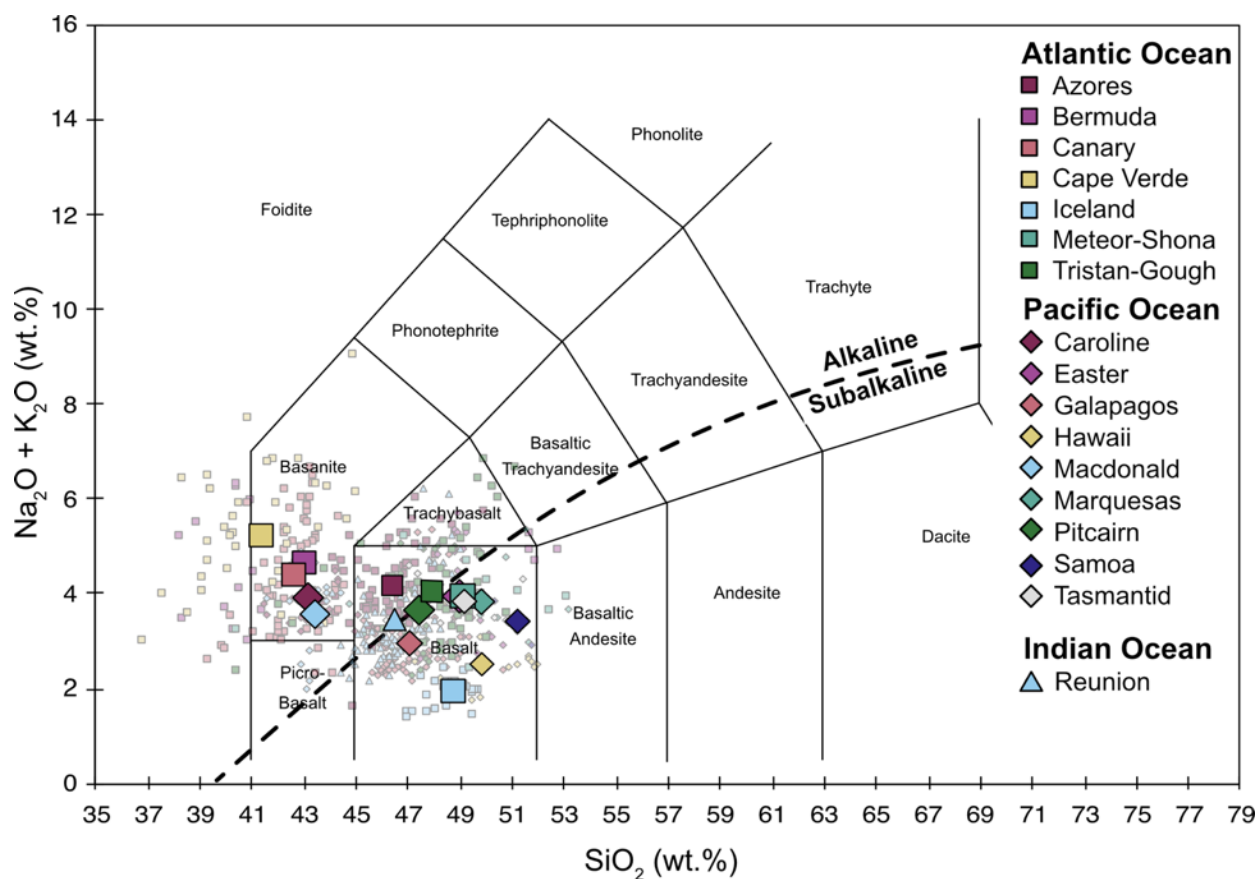


Figure S27. TAS plot of all basalt suites used in the study plotted with the alkaline and subalkaline discriminate line. Small symbols with muted colors represent all samples from each respective dataset. Large, opaque symbols represent the average for each OIB.

Cape Verde

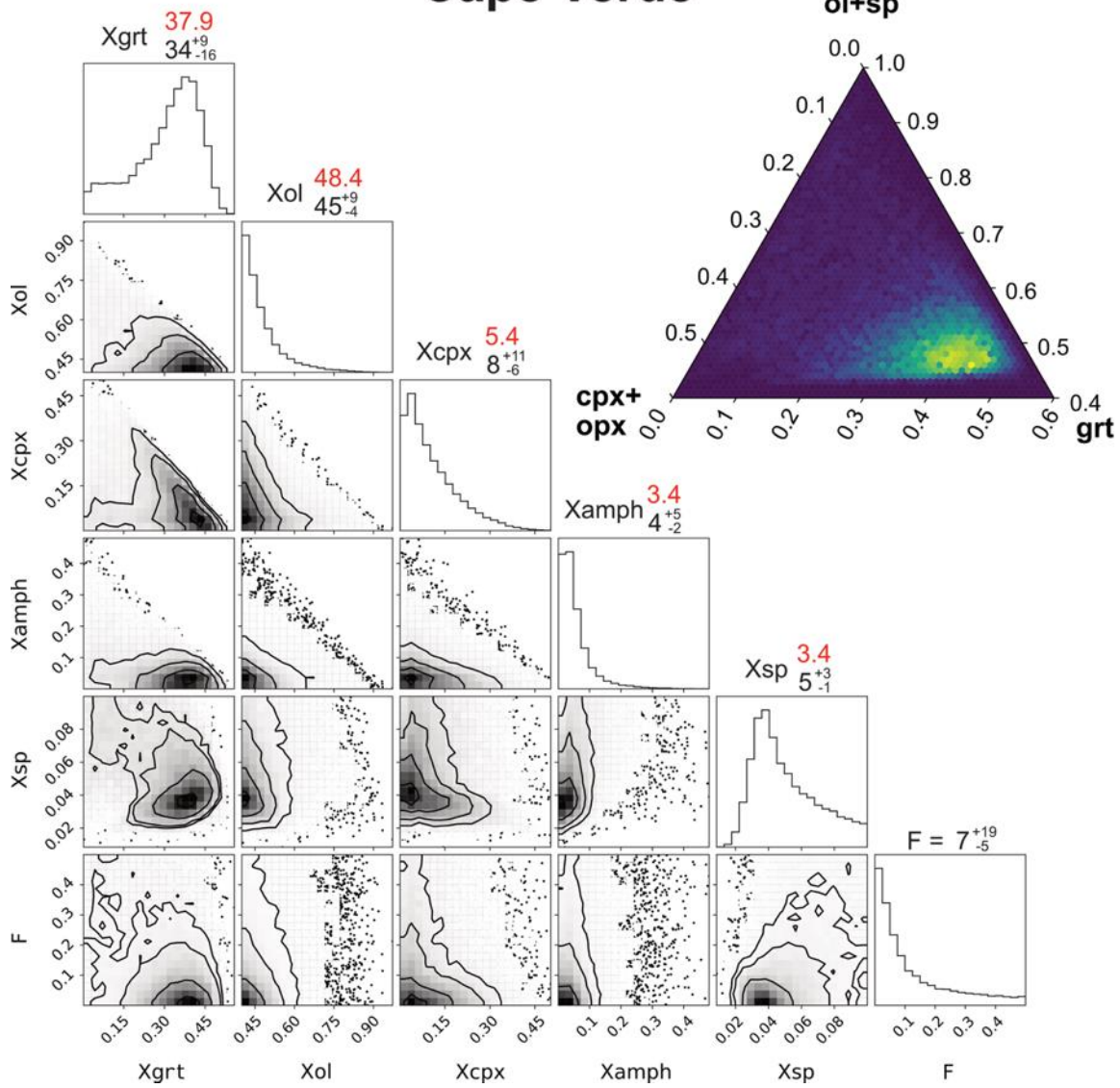


Figure S28. BaSIC with amphibole outputs for Cape Verde

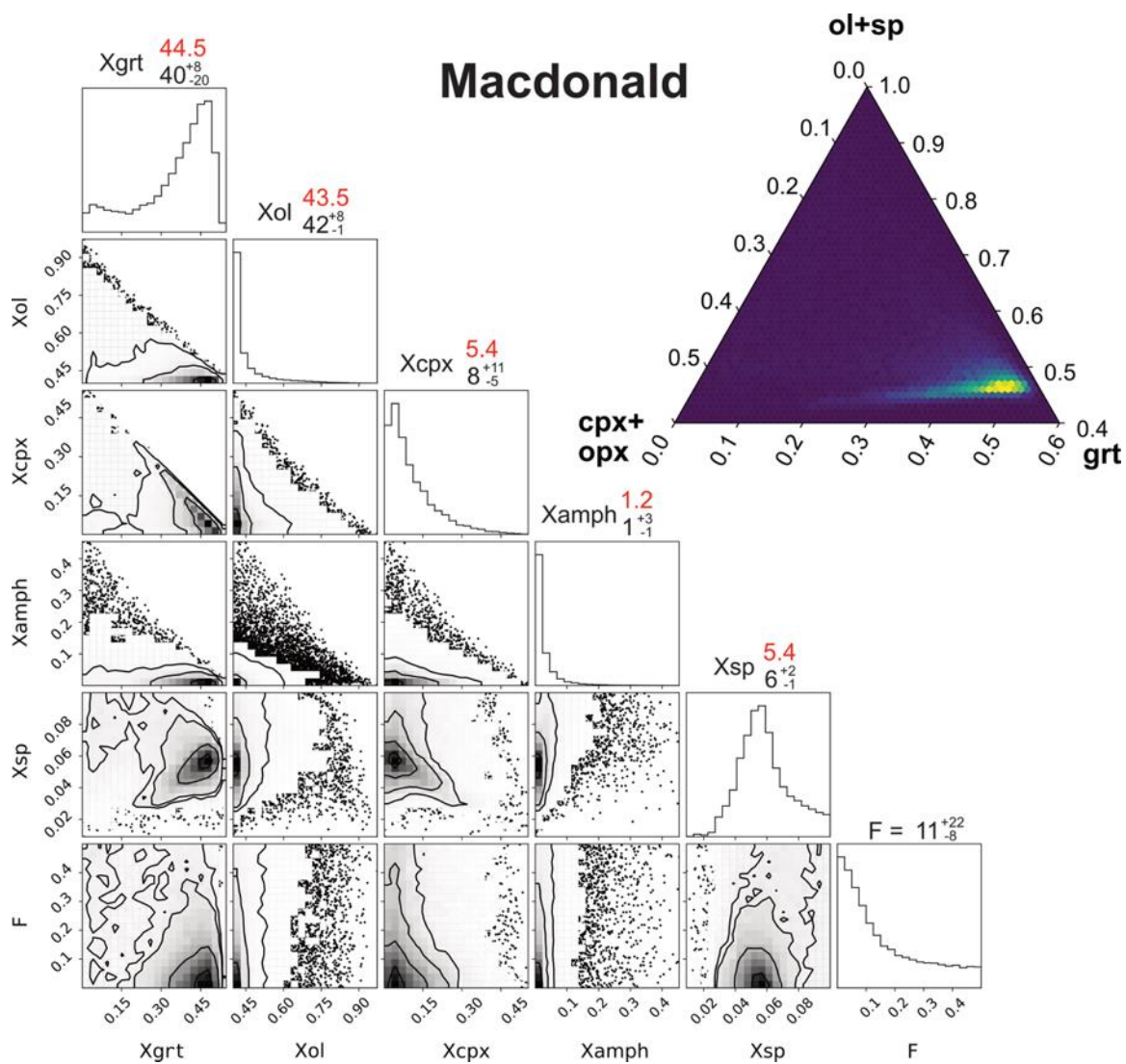


Figure S29. BaSIC with amphibole outputs for Macdonald

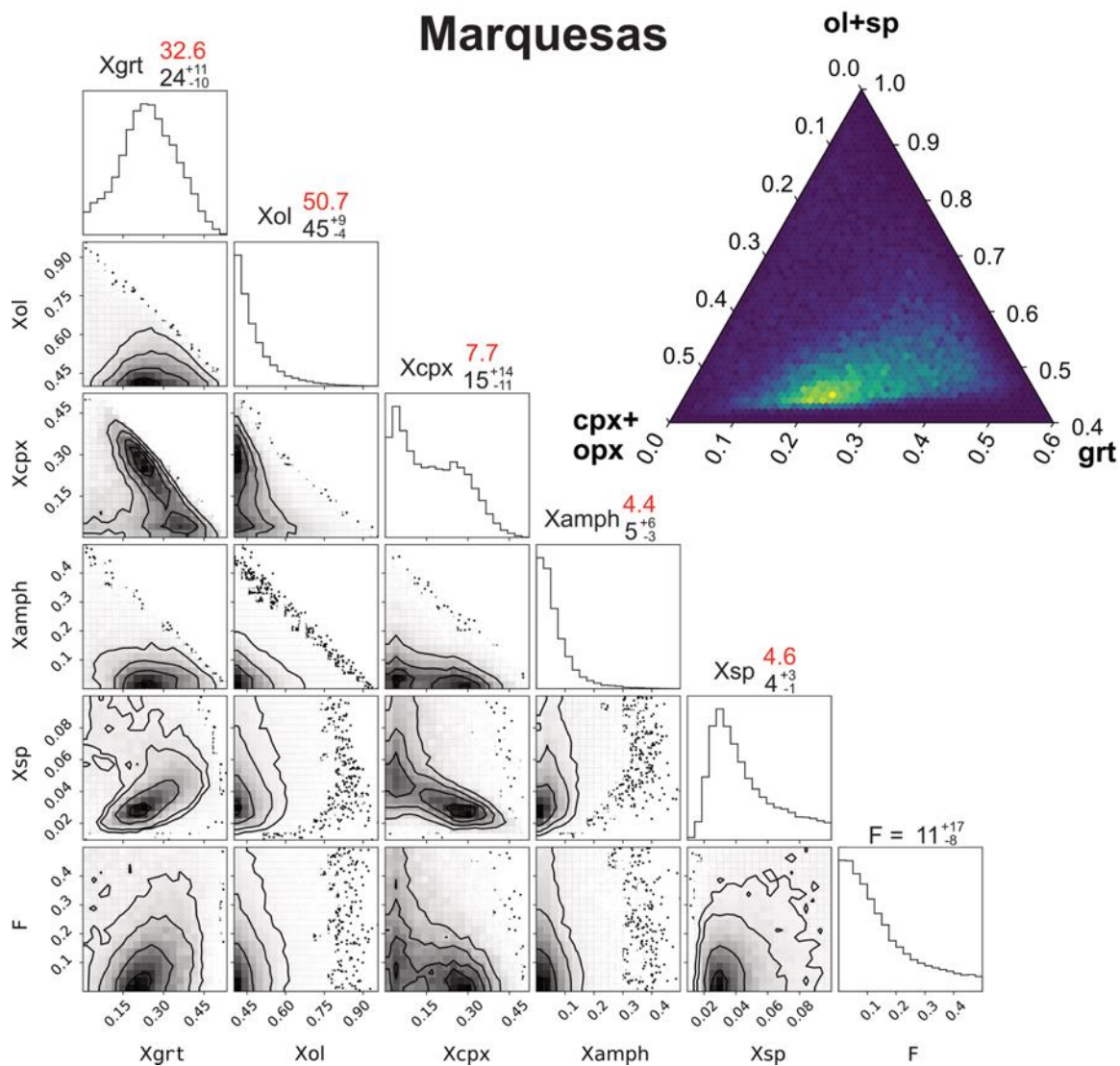


Figure S30. BaSIC with amphibole outputs for Marquesas