Redone Stats

2023-02-02

Import Packages

Build Radiocarbon Data

The code below calibrates radiocarbon data from Table 1 in the text with SHCal20 for the four layers at Sehonghong.

```
# Input is from Pargeter et al. (2017)
# Refer to article for full table with dates and lab ID
cal <- rcarbon::calibrate(x = c(11090, 12180, 12200, 12250, 12410, 12470,
                                12800, 13000, 13200, 20600, 15700, 17820),
                          errors = c(230, 11, 250, 300, 45, 100,
                                     250, 140, 150, 100, 150, 270),
                          calCurves = "shcal20")
```

```
## [1] "Calibrating radiocarbon ages..."
##   |                                                                      |
## [1] "Done."
```

```
summary(cal)
```

```
##    DateID MedianBP  OneSigma_BP_1  OneSigma_BP_2  TwoSigma_BP_1  TwoSigma_BP_2
## 1       1    12982 13159 to 13129 13119 to 12768 13420 to 12618 12525 to 12518
## 2       2    14054 14077 to 14035       NA to NA 14100 to 14006 13919 to 13882
## 3       3    14212 14809 to 14708 14523 to 13783 15046 to 13582 13549 to 13515
## 4       4    14321 14834 to 14680 14613 to 13798 15226 to 13571 13559 to 13504
## 5       5    14451 14803 to 14715 14512 to 14245 14845 to 14666 14634 to 14165
## 6       6    14589 14875 to 14769 14744 to 14324 15023 to 14147       NA to NA
## 7       7    15165 15652 to 14834 14681 to 14609 15894 to 14184       NA to NA
## 8       8    15508 15700 to 15297       NA to NA 15920 to 15118       NA to NA
## 9       9    15798 16027 to 15582       NA to NA 16229 to 15330       NA to NA
## 10     10    24773 24954 to 24619       NA to NA 25076 to 24357       NA to NA
## 11     11    18956 19094 to 18811       NA to NA 19331 to 18685       NA to NA
## 12     12    21563 21973 to 21195       NA to NA 22238 to 20880       NA to NA
```

```
dir <- here::here()
```

Import data

```
# Import data from directory
df.data <- read.csv(paste0(dir,"/data/Seh 2016 survey recording system_complete_03.17.17.csv"), header="

# Remove previously identified quarries from new surveyed areas
df.data <- df.data[-c(which(df.data$survey_square_id=="Chert outcrop 2" |
                        df.data$survey_square_id=="calcite sample" |
                          df.data$survey_square_id=="Dolerite outcrop" |
```

```
                            df.data$survey_square_id=="Chert quarry sehonghong village" |
                            df.data$survey_square_id=="dolerite sample" |
                            df.data$survey_square_id=="Hornfels sample" |
                            df.data$survey_square_id=="Seh-a" |
                            df.data$survey_square_id=="Seh-b" |
                            df.data$survey_square_id=="Seh-c" |
                            df.data$survey_square_id=="Seh-d" |
                            df.data$survey_square_id=="Seh-e" |
                            df.data$survey_square_id=="SEH-chert outcrop 3")),]


# Subset the data based upon only the lithics recorded at Sehonghong
df.land <- df.data |>
  dplyr::select(survey_square_id, Location, Latitude_x_min, Longitude_y_min, Raw.material.type,
         Length, Width, Thickness, Mass)

colnames(df.land) <- c("ID", "Environment", "x", "y", "Lithic", "Length", "Width", "Thickness", "Mass")

df.land[which(df.land$Lithic=="agate"), "Lithic"] <- "Agate"
df.land[which(df.land$Lithic=="coarse chert"), "Lithic"] <- "CoarseChert"
df.land[which(df.land$Lithic=="crystal quartz"), "Lithic"] <- "CrystallineQuartz"
df.land[which(df.land$Lithic=="dolerite" | df.land$Lithic=="Dolerite"), "Lithic"] <- "Dolerite"
df.land[which(df.land$Lithic=="fine chert" | df.land$Lithic=="Fine chert"), "Lithic"] <- "Fine Chert"
df.land[which(df.land$Lithic=="quartzite"), "Lithic"] <- "Quartzite"
df.land[which(df.land$Lithic=="sandstone"), "Lithic"] <- "Sandstone"

df.land <- df.land |>
  dplyr::filter(Lithic %in% c("Agate", "CoarseChert", "CrystallineQuartz", "Dolerite", "Fine Chert", "Q

# Calculate the volume for all nodules
df.data$V <- (4/3)*pi*(df.data$Length/2)*(df.data$Width/2)*(df.data$Thickness/2)

# Calculate surface area for all nodules
p=1.6075 # Exponent for elliptical surface area
df.data$SA <- 4*pi*((((((df.data$Length/2)^p)*((df.data$Width/2)^p)) +
                            ((((df.data$Length/2)^p)*((df.data$Thickness/2)^p))) +
                            ((((df.data$Width/2)^p)*((df.data$Thickness/2)^p))))/3)^(1/p))
```

Import Sehonghong Data

Merge Flake and Core Data

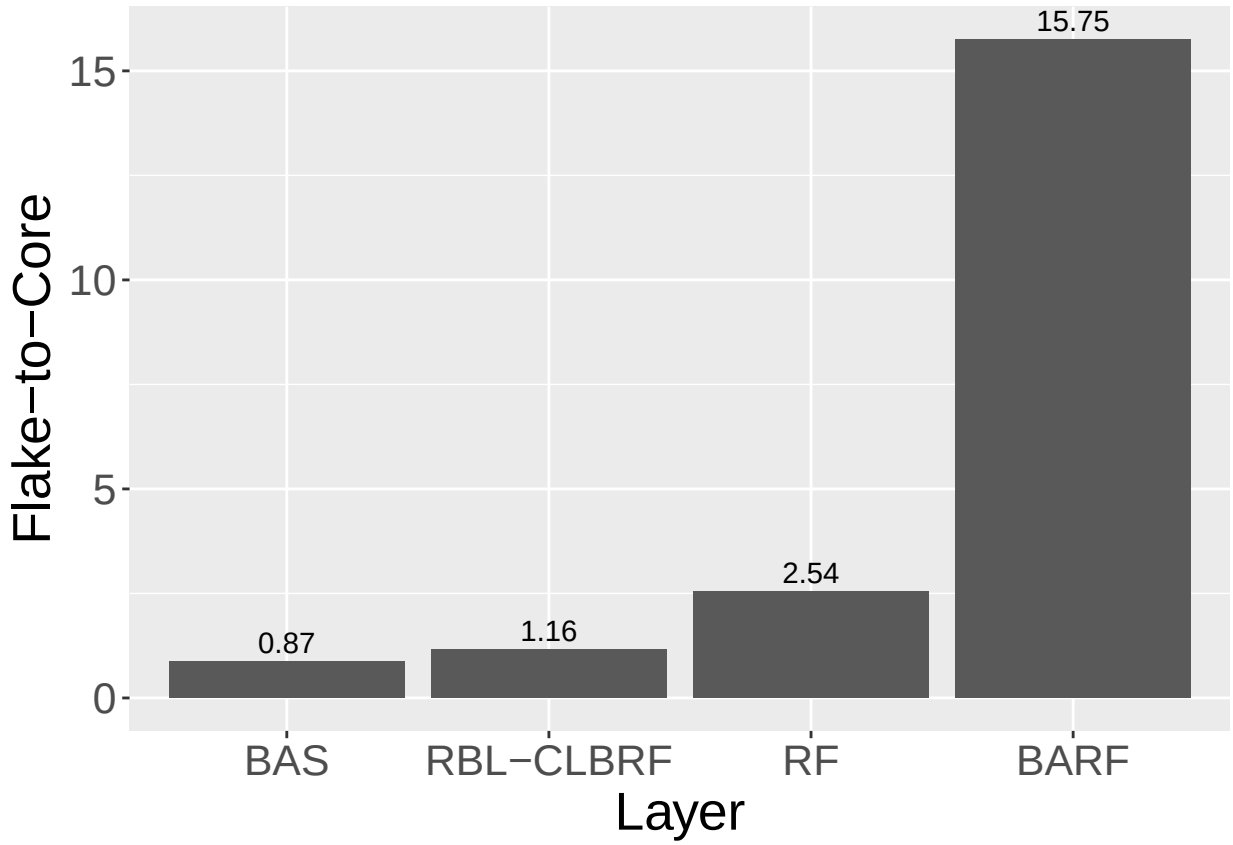
Here, we will compute the flake-to-core ratios with combined datasets

```
flakes <- data.flake |>
  dplyr::select(RawMaterial, Level) |>
  mutate(Class = rep("flake", nrow(data.flake)))

cores <- data.core |>
  dplyr::select(RawMaterial, Level) |>
  mutate(Class = rep("core", nrow(data.core)))

# Caluclate flake-to-core ratios
seh_merge <- rbind(flakes, cores)
```

```
seh_merge |>
  dplyr::filter(RawMaterial=="FineChert") |>
  dplyr::group_by(RawMaterial, Level, Class) |>
  dplyr::summarize(count=n()) |>
  dplyr::group_by(Class)
```

```
## # A tibble: 8 x 4
## # Groups:   Class [2]
##   RawMaterial Level     Class count
##   <chr>       <fct>     <chr> <int>
## 1 FineChert   barf      core      4
## 2 FineChert   barf      flake    63
## 3 FineChert   bas       core     61
## 4 FineChert   bas       flake    53
## 5 FineChert   rbl-clbrf core     74
## 6 FineChert   rbl-clbrf flake    86
## 7 FineChert   rf        core     24
## 8 FineChert   rf        flake    61
```

```
# Construct dataframe using the ratios calculated above
flake_core_ratio <- data.frame(Level = c("BAS", "RBL-CLBRF", "RF", "BARF"),
                               Flake_to_Core = c(53/61, 86/74, 61/24, 63/4))

# Visualize the flake-to-core ratio
flake_core_ratio |>
  mutate(Level = factor(Level, levels = c("BAS", "RBL-CLBRF", "RF", "BARF")))|>
  ggplot() +
  geom_bar(aes(x=Level, y=Flake_to_Core), stat="identity") +
  ylab("Flake-to-Core") +
  xlab("Layer") +
  theme(text=element_text(size=20))+
  geom_text(aes(y = Flake_to_Core, x = Level,
                label=round(Flake_to_Core, 2),
                vjust = -0.4))
```



Compile Cortical to non-cortical data

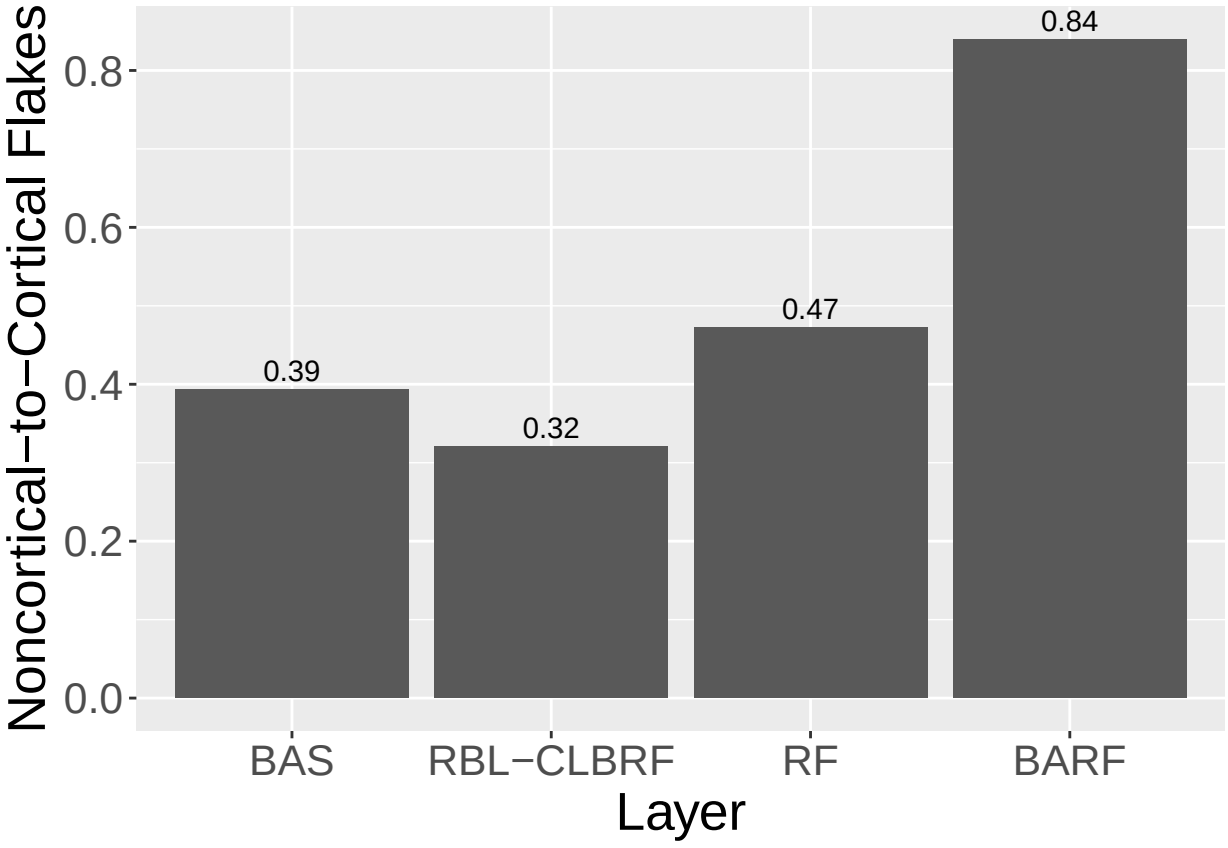
Below, the noncortical to cortical flakes show high amounts of cortex in BAS and RBL-CLBRF. COmbine this with the low flake to core ratio and this suggest local movement and materials being depsotied. As we transition to RF, we still have a lot of cores deposited but far less cortex, suggesting a potential affect of changes in knapping behavior that does not focus on cortical cores as much (little cortex but still a lot of cores to flakes). BARF is a clear change with little cortex to noncortex and very few cores compared to flakes, suggesting massive switch in procurement and mobility.

```
# Summarize the proportion of cortical surface area
data.flake |>
  dplyr::group_by(CortexArea, Level) |>
  dplyr::select(CortexArea) |>
  mutate(CortexArea = factor(CortexArea, levels=c("0%","1-9%", "11-40%","61-90%", "41-60%", "91-99%","1
         Level = factor(Level, levels=c("bas", "rbl-clbrf", "rf", "barf"))) |>
  dplyr::summarize(count=n()) -> seh_cortex

# Separate cortex from non-cortical
seh_ncortex <- seh_cortex
seh_ncortex$CortexArea <- ifelse(seh_cortex$CortexArea=="0%", "Non-cortical", "Cortical")
seh_ncortex |>
  dplyr::group_by(CortexArea, Level) |>
  dplyr::summarize(count=sum(count))
```

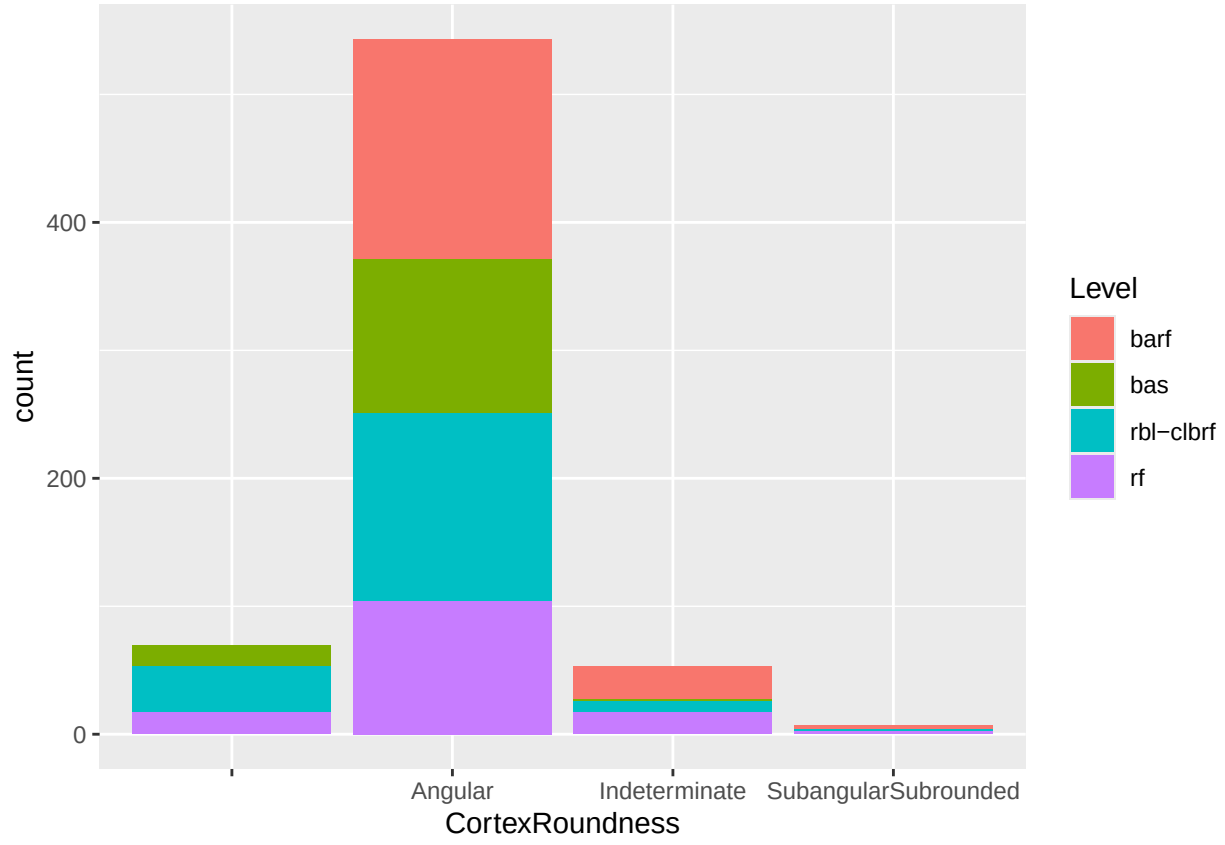
```
## # A tibble: 8 x 3
## # Groups:   CortexArea [2]
```

```
##   CortexArea   Level     count
##   <chr>        <fct>     <int>
## 1 Cortical     bas          56
## 2 Cortical     rbl-clbrf    78
## 3 Cortical     rf           55
## 4 Cortical     barf         56
## 5 Non-cortical bas          22
## 6 Non-cortical rbl-clbrf    25
## 7 Non-cortical rf           26
## 8 Non-cortical barf         47
```

```r
# Create dataframe
noncort_to_cort <- data.frame(Level = c("BAS", "RBL-CLBRF", "RF", "BARF"),
                              NonCort_to_Cort = c(22/56,25/78,26/55,47/56))

# Visulaize noncortical-to-cortical ratios
noncort_to_cort |>
  mutate(Level = factor(Level, levels = c("BAS", "RBL-CLBRF", "RF", "BARF")))|>
  ggplot() +
  geom_bar(aes(x=Level, y=NonCort_to_Cort), stat="identity") +
  ylab("Noncortical-to-Cortical Flakes") +
  xlab("Layer") +
  theme(text=element_text(size=20))+
  geom_text(aes(y = NonCort_to_Cort, x = Level,
                label=round(NonCort_to_Cort, 2),
                vjust = -0.4))
```

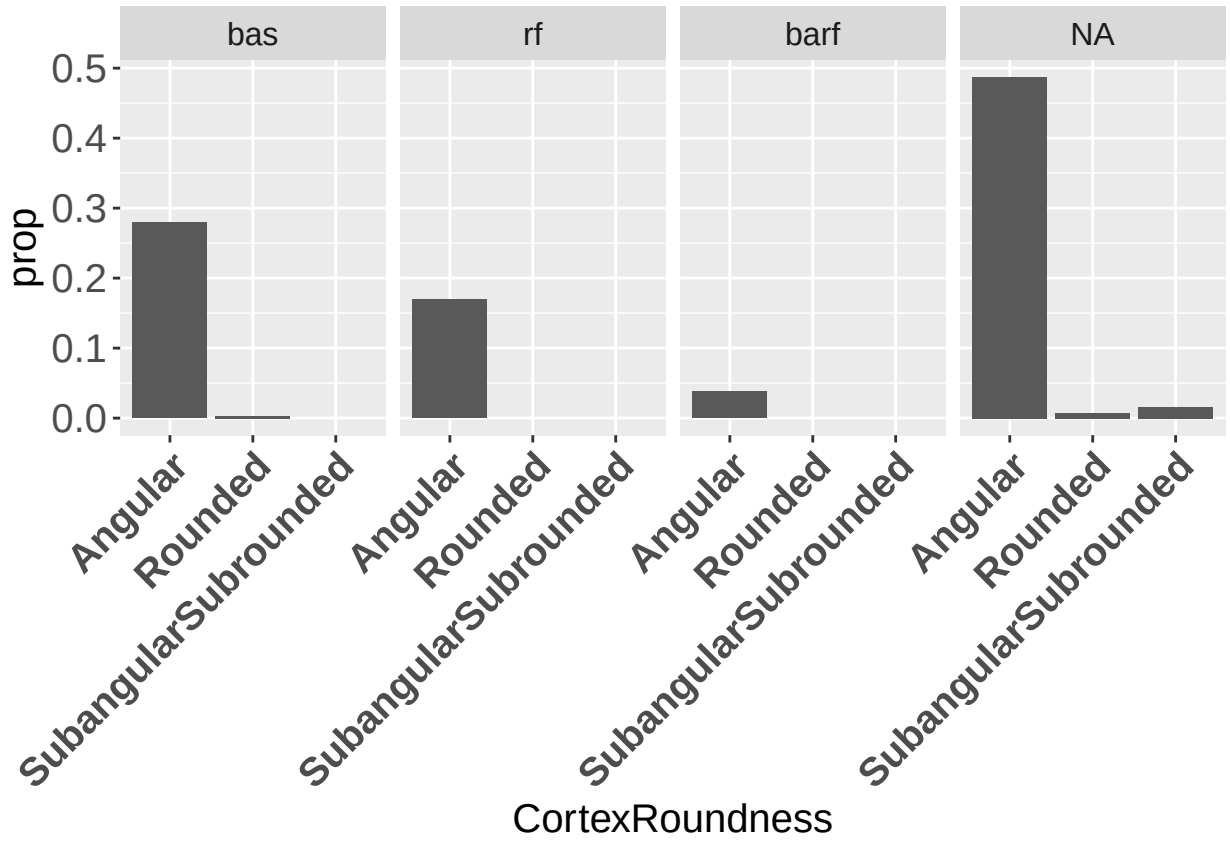


```r
# Add an analysis on the cortex roundness by layer
df.flake |>
  dplyr::filter(RawMaterial=="FineChert")|>
  dplyr::group_by(CortexRoundness, Level) |>
  dplyr::select(CortexRoundness) |>
  dplyr::filter(Level == "bas" | Level == "rbl" | Level == "clbrf" | Level == "rf" | Level == "barf") |>
  mutate(CortexArea = factor(CortexRoundness, levels=c("Angular", "SubangularSubrounded", "Rounded", "In
  dplyr::summarize(count=n()) -> seh_cortex

for(i in 1:nrow(seh_cortex)){
  if(seh_cortex[i,"Level"]=="rbl" | seh_cortex[i,"Level"]=="clbrf"){
    seh_cortex[i, "Level"] <- "rbl-clbrf"
  }
}

ggplot(seh_cortex, aes(x=CortexRoundness, y=count, fill=Level)) +
  geom_bar(stat="identity")
```




```r
df.core |>
    dplyr::group_by(CortexRoundness, Level) |>
    dplyr::select(CortexRoundness) |>
    dplyr::summarise(count=n()) -> seh_cortex

seh_cortex |>
  dplyr::filter(CortexRoundness != "")|>
  dplyr::mutate(Level = factor(Level, levels = c("bas", "rf", "rbl-clbrf", "barf")))|>
```

```
  dplyr::group_by(Level) |>
  mutate(s = sum(count)) |>
  mutate(prop = count/s) |>
  ggplot() +
  geom_bar(aes(x=CortexRoundness, y = prop), stat="identity") +
  facet_grid(~Level)+
  theme(axis.text.x = element_text(face = "bold", angle = 45, hjust=1, size=15),
        axis.text.y = element_text(size=15),
        text = element_text(size=15))
```



Description of Landscape Survey

Compute ANOVA for Mass as a Function of Lithic Material and Environment

```
# Model 1
aov1 <- aov(lm.land <- lm(log(Mass)~Lithic*Environment, data=df.land))
summary(aov1)
```

```
##                     Df Sum Sq Mean Sq F value   Pr(>F)
## Lithic               6  302.2   50.36   41.01  < 2e-16 ***
## Environment          1   33.1   33.14   26.98 2.77e-07 ***
## Lithic:Environment   4   21.0    5.26    4.28    0.002 **
## Residuals          634  778.6    1.23
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## 4281 observations deleted due to missingness
```

```
# Pairwise comparison
tuk.aov1 <- TukeyHSD(aov1)
round(tuk.aov1$`Lithic:Environment`[which(tuk.aov1$`Lithic:Environment`[,4]<.05),],3)
```

```
##                                                diff    lwr    upr p adj
## Dolerite:Riverine-Agate:Riverine                1.896  1.178  2.613 0.000
## Quartzite:Riverine-Agate:Riverine               2.083  0.430  3.735 0.002
## Sandstone:Riverine-Agate:Riverine               2.262  1.562  2.962 0.000
## Dolerite:Terrestrial-Agate:Riverine             1.742  0.984  2.499 0.000
## Quartzite:Terrestrial-Agate:Riverine            1.052  0.303  1.801 0.000
## Sandstone:Terrestrial-Agate:Riverine            1.279  0.485  2.073 0.000
## Dolerite:Riverine-CrystallineQuartz:Riverine    2.491  0.313  4.670 0.010
## Quartzite:Riverine-CrystallineQuartz:Riverine   2.678  0.040  5.316 0.043
## Sandstone:Riverine-CrystallineQuartz:Riverine   2.858  0.685  5.030 0.001
## Dolerite:Terrestrial-CrystallineQuartz:Riverine 2.337  0.145  4.529 0.024
## Fine Chert:Riverine-Dolerite:Riverine          -2.294 -4.472 -0.115 0.028
## Agate:Terrestrial-Dolerite:Riverine            -2.299 -3.286 -1.311 0.000
## CoarseChert:Terrestrial-Dolerite:Riverine      -0.998 -1.914 -0.083 0.018
## Fine Chert:Terrestrial-Dolerite:Riverine       -1.817 -2.693 -0.940 0.000
## Quartzite:Terrestrial-Dolerite:Riverine        -0.843 -1.350 -0.337 0.000
## Sandstone:Terrestrial-Dolerite:Riverine        -0.617 -1.188 -0.046 0.021
## Sandstone:Riverine-Fine Chert:Riverine          2.660  0.487  4.833 0.003
## Agate:Terrestrial-Quartzite:Riverine           -2.486 -4.272 -0.699 0.000
## Fine Chert:Terrestrial-Quartzite:Riverine      -2.004 -3.731 -0.276 0.008
## Agate:Terrestrial-Sandstone:Riverine           -2.665 -3.640 -1.690 0.000
## CoarseChert:Terrestrial-Sandstone:Riverine     -1.365 -2.267 -0.463 0.000
## Dolerite:Terrestrial-Sandstone:Riverine        -0.521 -1.015 -0.026 0.028
## Fine Chert:Terrestrial-Sandstone:Riverine      -2.183 -3.046 -1.321 0.000
## Quartzite:Terrestrial-Sandstone:Riverine       -1.210 -1.692 -0.728 0.000
## Sandstone:Terrestrial-Sandstone:Riverine       -0.983 -1.533 -0.434 0.000
## CoarseChert:Terrestrial-Agate:Terrestrial       1.300  0.034  2.566 0.037
## Dolerite:Terrestrial-Agate:Terrestrial          2.144  1.128  3.161 0.000
## Quartzite:Terrestrial-Agate:Terrestrial         1.455  0.445  2.466 0.000
## Sandstone:Terrestrial-Agate:Terrestrial         1.682  0.637  2.726 0.000
## Fine Chert:Terrestrial-Dolerite:Terrestrial    -1.662 -2.572 -0.753 0.000
## Quartzite:Terrestrial-Dolerite:Terrestrial     -0.689 -1.251 -0.128 0.003
## Quartzite:Terrestrial-Fine Chert:Terrestrial    0.973  0.071  1.876 0.021
## Sandstone:Terrestrial-Fine Chert:Terrestrial    1.200  0.260  2.140 0.002
```

```
# Simple count data for observation per raw material and environment and survey area (ID)
df.land %>%
  dplyr::select(Lithic, Mass, Environment) %>%
  dplyr::filter(!is.na(Mass)) %>%
  dplyr::group_by(Lithic, Environment) %>%
  dplyr::summarise(count=n(), Mass=sum(Mass))
```

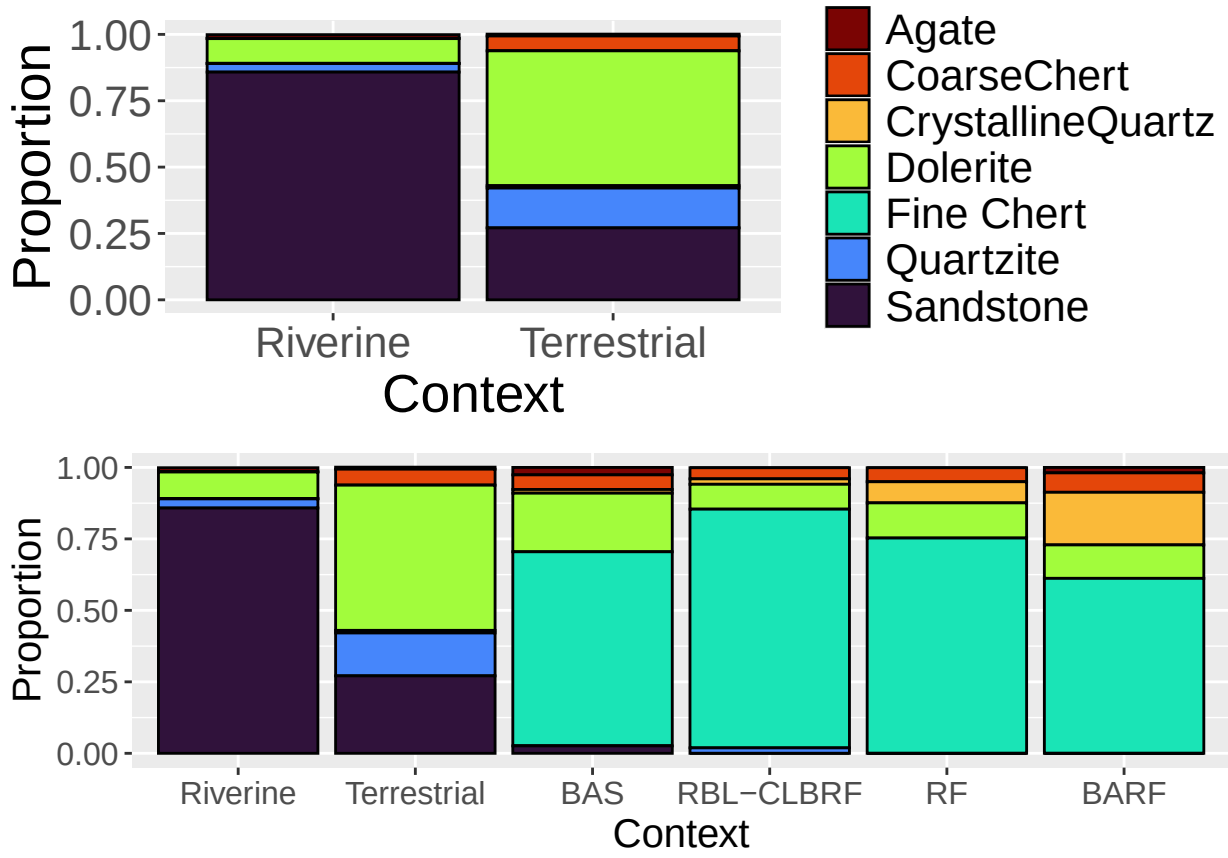
```
## # A tibble: 12 x 4
## # Groups:   Lithic [7]
##    Lithic            Environment count   Mass
##    <chr>             <chr>       <int>  <dbl>
##  1 Agate             Riverine       34   712.
##  2 Agate             Terrestrial    16   190.
##  3 CoarseChert       Terrestrial    19  1245.
```

```
##  4 CrystallineQuartz Riverine        3    25
##  5 Dolerite          Riverine      132 30133
##  6 Dolerite          Terrestrial    85 13048.
##  7 Fine Chert        Riverine        3    33
##  8 Fine Chert        Terrestrial    21   554
##  9 Quartzite         Riverine        6  1144.
## 10 Quartzite         Terrestrial    92  6937.
## 11 Sandstone         Riverine      172 50864.
## 12 Sandstone         Terrestrial    63  6648.
```

Compare Survey Data to Sehonghong Flakes

```
# COmpute proportions of lithic material by environment (landscape survey)
land.table <- table(df.land$Lithic, df.land$Environment)
land.prop <- round(prop.table(land.table,2),3)

# COmpute proportions of lithic by excavation level
flake.table <- table(data.flake$RawMaterial, data.flake$Level)
flake.prop <- round(prop.table(flake.table,2),3)

# COmbine above two proportions
prop.flake_land <- as.data.frame(cbind(land.prop, flake.prop))
prop.flake_land$Lithic <- rownames(land.prop)

# Rearrange levels for stratigraphic ordering
prop.flake_land <- prop.flake_land[,c(1:2,4,5,6,3,7)]

prop.flake_land <- gather(prop.flake_land, "Context", "Proportion",c(Riverine, Terrestrial, barf, bas,
#prop.flake_land$Context <- as.factor(prop.flake_land$Context)
prop.flake_land$Context <- factor(prop.flake_land$Context, levels=c("Riverine", "Terrestrial",
                                                                    "bas", "rbl-clbrf",
                                                                    "rf", "barf"))


# Stacked plot with lithic as grouping variable

plot1 <- ggplot(prop.flake_land[1:14,], aes(x=as.factor(Context), y=Proportion, fill=Lithic)) +
  geom_bar(position="stack", stat="identity", colour="black") +
  xlab("Context") +
  scale_fill_viridis_d(option="turbo", direction=-1)+
  theme(legend.title=element_blank(), text=element_text(size=20))

plot2 <- ggplot(prop.flake_land, aes(x=as.factor(Context), y=Proportion, fill=Lithic)) +
  geom_bar(position="stack", stat="identity", colour="black") +
  xlab("Context") +
  scale_fill_viridis_d(option="turbo", direction=-1,labels=c("Agate",
                                     "Coarse Chert",
                                     "Crystalline Quartz",
                                     "Dolerite",
                                     "Fine Chert",
                                     "Quartzite",
                                     "Sandstone"))+
  theme(text=element_text(size=15))+
```

```
  theme(legend.title=element_blank())+
  scale_x_discrete(labels=c("bas"="BAS", "rbl-clbrf"="RBL-CLBRF","rf"="RF","barf"="BARF"))

plot_grid(plot1,
          plot2+theme(legend.position = "none"),
          ncol=1)
```



Chi-square tests

```
########################################
#proportion testing
########################################
land.t <- land.table[1:7]
land.r <- land.table[8:14]

land.dat <- data.frame("Riverine"=land.r,
                       "Terrestrial"=land.t,
                       "barf"=flake.table[1:7],
                       "bas"=flake.table[8:14],
                       "rbl-clbrf"=flake.table[15:21],
                       "rf"=flake.table[22:28])

land.dat_tbl <- as.table(rbind(c(34, 16, 3, 3, 1, 2),
                               c(0, 19, 29, 16, 13, 16),
                               c(3, 0, 44, 12, 10, 21),
```

```
                              c(132, 85, 28, 59, 36, 56),
                              c(3, 21, 201, 138, 194, 140),
                              c(6, 92, 0, 2, 10, 15),
                              c(171, 63, 0, 4, 6, 1)))
rnames <- rownames(land.table)
cnames <- colnames(land.dat)
dimnames(land.dat_tbl) <- list(Material = rnames,
                              Context = cnames)

# Test for difference in raw material frequency
chisq.test(land.dat_tbl)
```

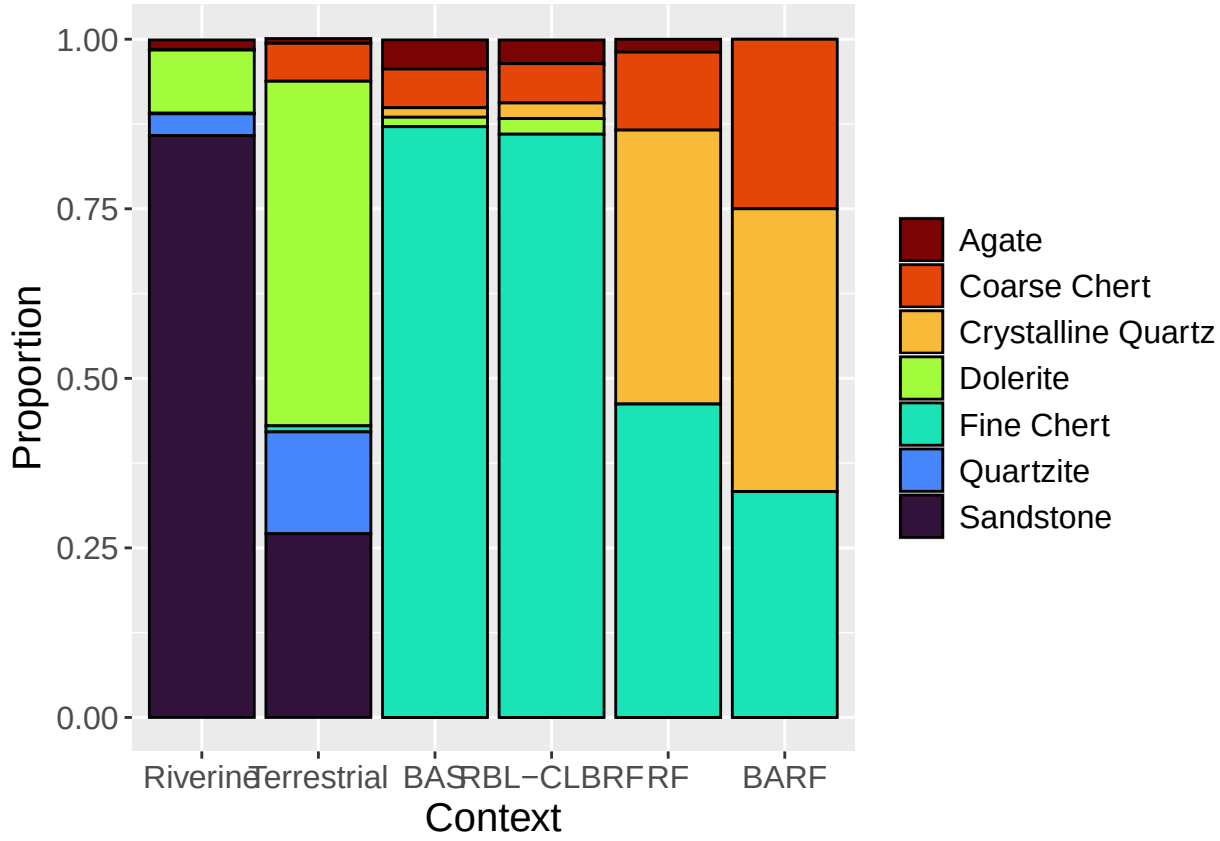
```
##
##  Pearson's Chi-squared test
##
## data:  land.dat_tbl
## X-squared = 1329.3, df = 30, p-value < 2.2e-16
```

```
# Pairwise test
chisq.posthoc.test::chisq.posthoc.test(land.dat_tbl)
```

```
##            Dimension     Value   Riverine Terrestrial      barf        bas
## 1              Agate Residuals   7.199567   2.0139768 -2.611699 -1.9628032
## 2              Agate  p values   0.000000   1.0000000  0.378392  1.0000000
## 3        CoarseChert Residuals  -5.031576   0.8037078  3.440289  1.0030108
## 4        CoarseChert  p values   0.000020   1.0000000  0.024406  1.0000000
## 5  CrystallineQuartz Residuals  -4.139857  -4.4677364  7.884495 -0.1107622
## 6  CrystallineQuartz  p values   0.001460   0.0003320  0.000000  1.0000000
## 7           Dolerite Residuals   7.241058   2.4607318 -6.410496  0.7752798
## 8           Dolerite  p values   0.000000   0.5823470  0.000000  1.0000000
## 9         Fine Chert Residuals -17.053035 -13.0063788  9.809472  6.0616429
## 10        Fine Chert  p values   0.000000   0.0000000  0.000000  0.0000000
## 11         Quartzite Residuals  -4.510426  17.2445380 -5.420939 -4.0922003
## 12         Quartzite  p values   0.000272   0.0000000  0.000002  0.0017950
## 13         Sandstone Residuals  20.679155   3.7304788 -7.895047 -5.9438224
## 14         Sandstone  p values   0.000000   0.0080270  0.000000  0.0000000
##     rbl.clbrf         rf
## 1  -3.0280686 -2.5001667
## 2   0.1033710  0.5213670
## 3  -0.5045633  0.6949996
## 4   1.0000000  1.0000000
## 5  -1.2614930  2.3692057
## 6   1.0000000  0.7487060
## 7  -4.1959468 -0.3717649
## 8   0.0011410  1.0000000
## 9  11.2840841  5.1987280
## 10  0.0000000  0.0000080
## 11 -2.4927991 -0.8920467
## 12  0.5323100  1.0000000
## 13 -6.2024326 -6.8330124
## 14  0.0000000  0.0000000
```

Compare Survey Data to Sehonghong Cores

```
# Compute proportions of lithic material by environment (landscape survey)
land.table <- table(df.land$Lithic, df.land$Environment)
land.prop <- round(prop.table(land.table,2),3)

# Compute proportions of lithic by excavation level
core.table <- table(data.core$RawMaterial, data.core$Level)
core.prop <- round(prop.table(core.table,2),3)
core.prop <- core.prop[-6,]

rownames(core.prop) <- rownames(land.prop[-c(6:7),])

# Combine above two proportions
prop.core_land <- as.data.frame(cbind(land.prop[-c(6:7),], core.prop))

# Add back in proportions of
prop.core_land <- rbind(prop.core_land, c(.032, .150, rep(0,4)))
prop.core_land <- rbind(prop.core_land, c(.858, .271, rep(0,4)))
rownames(prop.core_land) <- rownames(land.prop)

prop.core_land$Lithic <- rownames(land.prop)



# Rearrange levels for stratigraphic ordering
prop.core_land <- prop.core_land[,c(1:2,4,5,6,3,7)]

prop.core_land <-
  gather(prop.core_land, "Context", "Proportion",c(Riverine, Terrestrial,
                                                   barf, bas, `rbl-clbrf`, rf))
#prop.core_land$Context <- as.factor(prop.core_land$Context)
prop.core_land$Context <-
  factor(prop.core_land$Context, levels=c("Riverine", "Terrestrial",
                                          "bas", "rbl-clbrf","rf", "barf"))

# Stacked plot with lithic as grouping variable
ggplot(prop.core_land, aes(x=as.factor(Context), y=Proportion, fill=Lithic)) +
  geom_bar(position="stack", stat="identity", colour="black") +
  xlab("Context") +
  scale_fill_viridis_d(option="turbo", direction=-1,labels=c("Agate",
                                    "Coarse Chert",
                                    "Crystalline Quartz",
                                    "Dolerite",
                                    "Fine Chert",
                                    "Quartzite",
                                    "Sandstone"))+
  theme(text=element_text(size=15))+
  theme(legend.title=element_blank()) +
  scale_x_discrete(labels=c("bas"="BAS", "rbl-clbrf"= "RBL-CLBRF",
                            "rf"= "RF","barf"= "BARF"))
```




```
#########################
# Stats
#########################
land.dat_tbl <- as.table(rbind(c(34, 16, 0, 3, 3, 1),
                               c(0, 19, 3, 4, 5, 6),
                               c(3, 0, 5, 1, 2, 21),
                               c(132, 85, 0, 1, 2, 0),
                               c(3, 21, 4, 61, 74, 24),
                               c(6, 92, 0, 0, 0, 0),
                               c(171, 63, 0, 0, 0, 0)))
rnames <- rownames(land.table)
cnames <- colnames(land.dat)
dimnames(land.dat_tbl) <- list(Material = rnames,
                               Context = cnames)

# Test for differences in frequency
## Fisher's test is used because many values have 0-entries
fisher_test(land.dat_tbl, simulate.p.value = T)
```

```
## # A tibble: 1 x 3
##       n      p p.signif
## * <dbl>  <dbl> <chr>
## 1   865 0.0005 ***
```

```
# Pairwise test
## Fisher's only accepts 2 dimensions at a time for each layer of Sehonghong and and riverine/terrestri
c <- 0
```

```r
for(i in 1:5){
  for(j in 2:(6-c)){
    print(paste("Showing results of",
                colnames(land.dat_tbl)[i],
                "and",
                colnames(land.dat_tbl)[j]))
    print.data.frame(pairwise_fisher_test(land.dat_tbl[, c(i, j+c)], simulate.p.value=T))
  }
  c <- c + 1
}
```

```
## [1] "Showing results of Riverine and Terrestrial"
##               group1            group2   n        p    p.adj p.adj.signif
## 1              Agate       CoarseChert  69 1.28e-07 1.92e-06         ****
## 2              Agate CrystallineQuartz  53 5.45e-01 1.00e+00           ns
## 3              Agate          Dolerite 267 4.19e-01 1.00e+00           ns
## 4              Agate        Fine Chert  74 1.22e-05 1.59e-04          ***
## 5              Agate         Quartzite 148 2.26e-15 4.29e-14         ****
## 6              Agate         Sandstone 284 4.89e-01 1.00e+00           ns
## 7        CoarseChert CrystallineQuartz  22 6.49e-04 7.14e-03           **
## 8        CoarseChert          Dolerite 236 6.32e-08 1.01e-06         ****
## 9        CoarseChert        Fine Chert  43 2.43e-01 1.00e+00           ns
## 10       CoarseChert         Quartzite 117 5.87e-01 1.00e+00           ns
## 11       CoarseChert         Sandstone 253 1.05e-10 1.89e-09         ****
## 12 CrystallineQuartz          Dolerite 220 2.85e-01 1.00e+00           ns
## 13 CrystallineQuartz        Fine Chert  27 6.84e-03 6.69e-02           ns
## 14 CrystallineQuartz         Quartzite 101 5.04e-04 6.05e-03           **
## 15 CrystallineQuartz         Sandstone 237 5.67e-01 1.00e+00           ns
## 16          Dolerite        Fine Chert 241 5.14e-06 7.20e-05         ****
## 17          Dolerite         Quartzite 315 4.34e-22 8.68e-21         ****
## 18          Dolerite         Sandstone 451 6.69e-03 6.69e-02           ns
## 19        Fine Chert         Quartzite 122 3.77e-01 1.00e+00           ns
## 20        Fine Chert         Sandstone 258 7.34e-09 1.25e-07         ****
## 21         Quartzite         Sandstone 332 5.91e-32 1.24e-30         ****
## [1] "Showing results of Riverine and barf"
##               group1            group2   n        p    p.adj p.adj.signif
## 1              Agate       CoarseChert  37 1.29e-04 1.81e-03           **
## 2              Agate CrystallineQuartz  42 6.58e-05 9.87e-04          ***
## 3              Agate          Dolerite 166 1.00e+00 1.00e+00           ns
## 4              Agate        Fine Chert  41 3.46e-04 4.50e-03           **
## 5              Agate         Quartzite  40 1.00e+00 1.00e+00           ns
## 6              Agate         Sandstone 205 1.00e+00 1.00e+00           ns
## 7        CoarseChert CrystallineQuartz  11 4.91e-01 1.00e+00           ns
## 8        CoarseChert          Dolerite 135 2.49e-06 4.00e-05         ****
## 9        CoarseChert        Fine Chert  10 4.75e-01 1.00e+00           ns
## 10       CoarseChert         Quartzite   9 1.19e-02 1.43e-01           ns
## 11       CoarseChert         Sandstone 174 1.16e-06 2.09e-05         ****
## 12 CrystallineQuartz          Dolerite 140 1.34e-07 2.68e-06         ****
## 13 CrystallineQuartz        Fine Chert  15 1.00e+00 1.00e+00           ns
## 14 CrystallineQuartz         Quartzite  14 3.10e-02 3.41e-01           ns
## 15 CrystallineQuartz         Sandstone 179 3.87e-08 8.13e-07         ****
## 16          Dolerite        Fine Chert 139 2.35e-06 4.00e-05         ****
## 17          Dolerite         Quartzite 138 1.00e+00 1.00e+00           ns
## 18          Dolerite         Sandstone 303 1.00e+00 1.00e+00           ns
```

```
## 19        Fine Chert         Quartzite  13 6.99e-02 6.99e-01           ns
## 20        Fine Chert         Sandstone 178 8.66e-07 1.65e-05         ****
## 21         Quartzite         Sandstone 177 1.00e+00 1.00e+00           ns
## [1] "Showing results of Riverine and bas"
##               group1            group2   n        p    p.adj p.adj.signif
## 1              Agate       CoarseChert  41 3.46e-04 5.19e-03           **
## 2              Agate CrystallineQuartz  41 3.48e-01 1.00e+00           ns
## 3              Agate          Dolerite 170 3.27e-02 3.27e-01           ns
## 4              Agate        Fine Chert 101 6.02e-20 1.14e-18         ****
## 5              Agate         Quartzite  43 1.00e+00 1.00e+00           ns
## 6              Agate         Sandstone 208 5.26e-03 6.31e-02           ns
## 7        CoarseChert CrystallineQuartz   8 1.43e-01 1.00e+00           ns
## 8        CoarseChert          Dolerite 137 3.56e-07 6.05e-06         ****
## 9        CoarseChert        Fine Chert  68 1.00e+00 1.00e+00           ns
## 10       CoarseChert         Quartzite  10 4.76e-03 6.19e-02           ns
## 11       CoarseChert         Sandstone 175 2.65e-08 4.77e-07         ****
## 12 CrystallineQuartz          Dolerite 137 5.78e-02 5.20e-01           ns
## 13 CrystallineQuartz        Fine Chert  68 1.54e-03 2.16e-02            *
## 14 CrystallineQuartz         Quartzite  10 4.00e-01 1.00e+00           ns
## 15 CrystallineQuartz         Sandstone 175 2.29e-02 2.52e-01           ns
## 16          Dolerite        Fine Chert 197 4.69e-46 9.38e-45         ****
## 17          Dolerite         Quartzite 139 1.00e+00 1.00e+00           ns
## 18          Dolerite         Sandstone 304 4.38e-01 1.00e+00           ns
## 19        Fine Chert         Quartzite  70 6.41e-07 1.03e-05         ****
## 20        Fine Chert         Sandstone 235 2.55e-53 5.36e-52         ****
## 21         Quartzite         Sandstone 177 1.00e+00 1.00e+00           ns
## [1] "Showing results of Riverine and rbl.clbrf"
##               group1            group2   n        p    p.adj p.adj.signif
## 1              Agate       CoarseChert  42 6.58e-05 9.87e-04          ***
## 2              Agate CrystallineQuartz  42 9.94e-02 7.95e-01           ns
## 3              Agate          Dolerite 171 6.84e-02 6.16e-01           ns
## 4              Agate        Fine Chert 114 4.48e-22 8.51e-21         ****
## 5              Agate         Quartzite  43 1.00e+00 1.00e+00           ns
## 6              Agate         Sandstone 208 5.26e-03 5.79e-02           ns
## 7        CoarseChert CrystallineQuartz  10 1.67e-01 1.00e+00           ns
## 8        CoarseChert          Dolerite 139 5.22e-08 8.87e-07         ****
## 9        CoarseChert        Fine Chert  82 1.00e+00 1.00e+00           ns
## 10       CoarseChert         Quartzite  11 2.16e-03 2.77e-02            *
## 11       CoarseChert         Sandstone 176 7.53e-10 1.36e-08         ****
## 12 CrystallineQuartz          Dolerite 139 6.07e-03 6.07e-02           ns
## 13 CrystallineQuartz        Fine Chert  82 2.13e-03 2.77e-02            *
## 14 CrystallineQuartz         Quartzite  11 1.82e-01 1.00e+00           ns
## 15 CrystallineQuartz         Sandstone 176 6.49e-04 9.09e-03           **
## 16          Dolerite        Fine Chert 211 1.48e-50 2.96e-49         ****
## 17          Dolerite         Quartzite 140 1.00e+00 1.00e+00           ns
## 18          Dolerite         Sandstone 305 1.92e-01 1.00e+00           ns
## 19        Fine Chert         Quartzite  83 2.23e-07 3.57e-06         ****
## 20        Fine Chert         Sandstone 248 2.99e-60 6.28e-59         ****
## 21         Quartzite         Sandstone 177 1.00e+00 1.00e+00           ns
## [1] "Showing results of Riverine and rf"
##               group1            group2   n        p    p.adj p.adj.signif
## 1              Agate       CoarseChert  41 1.56e-06 2.03e-05         ****
## 2              Agate CrystallineQuartz  59 7.93e-12 1.27e-10         ****
## 3              Agate          Dolerite 167 2.10e-01 1.00e+00           ns
```

```
## 4              Agate        Fine Chert  62 6.97e-13 1.18e-11         ****
## 5              Agate         Quartzite  41 1.00e+00 1.00e+00           ns
## 6              Agate         Sandstone 206 1.70e-01 1.00e+00           ns
## 7        CoarseChert CrystallineQuartz  30 1.00e+00 1.00e+00           ns
## 8        CoarseChert          Dolerite 138 1.16e-10 1.62e-09         ****
## 9        CoarseChert        Fine Chert  33 1.00e+00 1.00e+00           ns
## 10       CoarseChert         Quartzite  12 2.16e-03 2.16e-02            *
## 11       CoarseChert         Sandstone 177 2.55e-11 3.82e-10         ****
## 12 CrystallineQuartz          Dolerite 156 3.72e-23 6.70e-22         ****
## 13 CrystallineQuartz        Fine Chert  51 1.00e+00 1.00e+00           ns
## 14 CrystallineQuartz         Quartzite  30 1.41e-04 1.55e-03           **
## 15 CrystallineQuartz         Sandstone 195 2.56e-25 4.86e-24         ****
## 16          Dolerite        Fine Chert 159 1.66e-25 3.32e-24         ****
## 17          Dolerite         Quartzite 138 1.00e+00 1.00e+00           ns
## 18          Dolerite         Sandstone 303 1.00e+00 1.00e+00           ns
## 19        Fine Chert         Quartzite  33 7.58e-05 9.10e-04          ***
## 20        Fine Chert         Sandstone 198 5.88e-28 1.23e-26         ****
## 21         Quartzite         Sandstone 177 1.00e+00 1.00e+00           ns
## [1] "Showing results of Terrestrial and Terrestrial"
##               group1            group2   n        p    p.adj p.adj.signif
## 1              Agate       CoarseChert  38 2.49e-01 1.00e+00           ns
## 2              Agate CrystallineQuartz  21 4.91e-05 8.84e-04          ***
## 3              Agate          Dolerite 101 1.00e+00 1.00e+00           ns
## 4              Agate        Fine Chert  41 1.43e-01 1.00e+00           ns
## 5              Agate         Quartzite 108 1.00e+00 1.00e+00           ns
## 6              Agate         Sandstone  79 1.00e+00 1.00e+00           ns
## 7        CoarseChert CrystallineQuartz  27 6.94e-04 1.18e-02            *
## 8        CoarseChert          Dolerite 107 7.76e-03 8.54e-02           ns
## 9        CoarseChert        Fine Chert  47 1.00e+00 1.00e+00           ns
## 10       CoarseChert         Quartzite 114 6.40e-03 7.68e-02           ns
## 11       CoarseChert         Sandstone  85 1.56e-02 1.56e-01           ns
## 12 CrystallineQuartz          Dolerite  90 2.28e-08 4.56e-07         ****
## 13 CrystallineQuartz        Fine Chert  30 8.84e-04 1.41e-02            *
## 14 CrystallineQuartz         Quartzite  97 1.55e-08 3.26e-07         ****
## 15 CrystallineQuartz         Sandstone  68 9.59e-08 1.82e-06         ****
## 16          Dolerite        Fine Chert 110 2.19e-03 3.07e-02            *
## 17          Dolerite         Quartzite 177 1.00e+00 1.00e+00           ns
## 18          Dolerite         Sandstone 148 1.00e+00 1.00e+00           ns
## 19        Fine Chert         Quartzite 117 1.71e-03 2.56e-02            *
## 20        Fine Chert         Sandstone  88 5.42e-03 7.05e-02           ns
## 21         Quartzite         Sandstone 155 1.00e+00 1.00e+00           ns
## [1] "Showing results of Terrestrial and barf"
##               group1            group2   n        p    p.adj p.adj.signif
## 1              Agate       CoarseChert  42 1.00e+00 1.00e+00           ns
## 2              Agate CrystallineQuartz  20 2.00e-01 1.00e+00           ns
## 3              Agate          Dolerite 105 1.82e-02 1.64e-01           ns
## 4              Agate        Fine Chert 101 3.49e-06 5.93e-05         ****
## 5              Agate         Quartzite 111 4.37e-03 6.26e-02           ns
## 6              Agate         Sandstone  82 1.09e-02 1.30e-01           ns
## 7        CoarseChert CrystallineQuartz  24 2.08e-01 1.00e+00           ns
## 8        CoarseChert          Dolerite 109 6.81e-03 8.85e-02           ns
## 9        CoarseChert        Fine Chert 105 1.08e-06 1.94e-05         ****
## 10       CoarseChert         Quartzite 115 1.28e-03 2.05e-02            *
## 11       CoarseChert         Sandstone  86 4.17e-03 6.26e-02           ns
```

```
## 12 CrystallineQuartz          Dolerite  87 2.30e-02 1.84e-01           ns
## 13 CrystallineQuartz        Fine Chert  83 1.00e+00 1.00e+00           ns
## 14 CrystallineQuartz         Quartzite  93 1.08e-02 1.30e-01           ns
## 15 CrystallineQuartz         Sandstone  64 1.56e-02 1.56e-01           ns
## 16          Dolerite        Fine Chert 168 4.03e-26 8.06e-25         ****
## 17          Dolerite         Quartzite 178 4.83e-01 1.00e+00           ns
## 18          Dolerite         Sandstone 149 1.00e+00 1.00e+00           ns
## 19        Fine Chert         Quartzite 174 3.23e-29 6.78e-28         ****
## 20        Fine Chert         Sandstone 145 4.12e-23 7.83e-22         ****
## 21         Quartzite         Sandstone 155 1.00e+00 1.00e+00           ns
## [1] "Showing results of Terrestrial and bas"
##               group1            group2   n        p    p.adj p.adj.signif
## 1              Agate       CoarseChert  43 1.00e+00 1.00e+00           ns
## 2              Agate CrystallineQuartz  21 4.76e-02 3.33e-01           ns
## 3              Agate          Dolerite 106 3.92e-02 3.14e-01           ns
## 4              Agate        Fine Chert 114 4.89e-07 8.31e-06         ****
## 5              Agate         Quartzite 111 4.37e-03 4.81e-02            *
## 6              Agate         Sandstone  82 1.09e-02 9.81e-02           ns
## 7        CoarseChert CrystallineQuartz  26 6.46e-02 3.88e-01           ns
## 8        CoarseChert          Dolerite 111 5.04e-03 5.04e-02           ns
## 9        CoarseChert        Fine Chert 119 3.65e-07 6.57e-06         ****
## 10       CoarseChert         Quartzite 116 2.65e-04 3.98e-03           **
## 11       CoarseChert         Sandstone  87 1.15e-03 1.50e-02            *
## 12 CrystallineQuartz          Dolerite  89 1.53e-03 1.84e-02            *
## 13 CrystallineQuartz        Fine Chert  97 1.00e+00 1.00e+00           ns
## 14 CrystallineQuartz         Quartzite  94 2.29e-04 3.66e-03           **
## 15 CrystallineQuartz         Sandstone  65 4.81e-04 6.73e-03           **
## 16          Dolerite        Fine Chert 182 7.79e-29 1.56e-27         ****
## 17          Dolerite         Quartzite 179 2.35e-01 1.00e+00           ns
## 18          Dolerite         Sandstone 150 5.10e-01 1.00e+00           ns
## 19        Fine Chert         Quartzite 187 3.18e-33 6.68e-32         ****
## 20        Fine Chert         Sandstone 158 3.66e-26 6.95e-25         ****
## 21         Quartzite         Sandstone 155 1.00e+00 1.00e+00           ns
## [1] "Showing results of Terrestrial and rbl.clbrf"
##               group1            group2   n        p    p.adj p.adj.signif
## 1              Agate       CoarseChert  42 2.10e-01 1.00e+00           ns
## 2              Agate CrystallineQuartz  38 7.64e-10 1.15e-08         ****
## 3              Agate          Dolerite 102 1.67e-01 1.00e+00           ns
## 4              Agate        Fine Chert  62 5.07e-04 4.56e-03           **
## 5              Agate         Quartzite 109 1.56e-01 1.00e+00           ns
## 6              Agate         Sandstone  80 2.13e-01 1.00e+00           ns
## 7        CoarseChert CrystallineQuartz  46 5.07e-08 7.10e-07         ****
## 8        CoarseChert          Dolerite 110 8.27e-05 9.10e-04          ***
## 9        CoarseChert        Fine Chert  70 2.36e-02 1.89e-01           ns
## 10       CoarseChert         Quartzite 117 5.66e-05 6.79e-04          ***
## 11       CoarseChert         Sandstone  88 3.27e-04 3.27e-03           **
## 12 CrystallineQuartz          Dolerite 106 1.26e-22 2.52e-21         ****
## 13 CrystallineQuartz        Fine Chert  66 4.76e-05 6.19e-04          ***
## 14 CrystallineQuartz         Quartzite 113 2.85e-23 5.98e-22         ****
## 15 CrystallineQuartz         Sandstone  84 3.06e-20 5.81e-19         ****
## 16          Dolerite        Fine Chert 130 4.15e-14 7.06e-13         ****
## 17          Dolerite         Quartzite 177 1.00e+00 1.00e+00           ns
## 18          Dolerite         Sandstone 148 1.00e+00 1.00e+00           ns
## 19        Fine Chert         Quartzite 137 1.04e-14 1.87e-13         ****
```

```
## 20        Fine Chert         Sandstone 108 5.86e-12 9.38e-11         ****
## 21         Quartzite         Sandstone 155 1.00e+00 1.00e+00           ns
## [1] "Showing results of barf and Terrestrial"
##               group1            group2  n        p   p.adj p.adj.signif
## 1              Agate       CoarseChert 10 4.75e-01 1.00000           ns
## 2              Agate CrystallineQuartz  9 4.76e-02 0.90400           ns
## 3              Agate          Dolerite  4 1.00e+00 1.00000           ns
## 4              Agate        Fine Chert 68 1.00e+00 1.00000           ns
## 5              Agate         Quartzite  3 1.00e+00 1.00000           ns
## 6              Agate         Sandstone  3 1.00e+00 1.00000           ns
## 7        CoarseChert CrystallineQuartz 13 2.66e-01 1.00000           ns
## 8        CoarseChert          Dolerite  8 1.00e+00 1.00000           ns
## 9        CoarseChert        Fine Chert 72 1.72e-02 0.34400           ns
## 10       CoarseChert         Quartzite  7 1.00e+00 1.00000           ns
## 11       CoarseChert         Sandstone  7 1.00e+00 1.00000           ns
## 12 CrystallineQuartz          Dolerite  7 2.86e-01 1.00000           ns
## 13 CrystallineQuartz        Fine Chert 71 5.51e-05 0.00116           **
## 14 CrystallineQuartz         Quartzite  6 1.00e+00 1.00000           ns
## 15 CrystallineQuartz         Sandstone  6 1.00e+00 1.00000           ns
## 16          Dolerite        Fine Chert 66 1.00e+00 1.00000           ns
## 17          Dolerite         Quartzite  1 1.00e+00 1.00000           ns
## 18          Dolerite         Sandstone  1 1.00e+00 1.00000           ns
## 19        Fine Chert         Quartzite 65 1.00e+00 1.00000           ns
## 20        Fine Chert         Sandstone 65 1.00e+00 1.00000           ns
## 21         Quartzite         Sandstone  0 1.00e+00 1.00000           ns
## [1] "Showing results of barf and barf"
##               group1            group2  n        p   p.adj p.adj.signif
## 1              Agate       CoarseChert 11 4.91e-01 1.00000           ns
## 2              Agate CrystallineQuartz 10 1.67e-01 1.00000           ns
## 3              Agate          Dolerite  5 1.00e+00 1.00000           ns
## 4              Agate        Fine Chert 81 1.00e+00 1.00000           ns
## 5              Agate         Quartzite  3 1.00e+00 1.00000           ns
## 6              Agate         Sandstone  3 1.00e+00 1.00000           ns
## 7        CoarseChert CrystallineQuartz 15 3.15e-01 1.00000           ns
## 8        CoarseChert          Dolerite 10 1.00e+00 1.00000           ns
## 9        CoarseChert        Fine Chert 86 1.59e-02 0.31800           ns
## 10       CoarseChert         Quartzite  8 1.00e+00 1.00000           ns
## 11       CoarseChert         Sandstone  8 1.00e+00 1.00000           ns
## 12 CrystallineQuartz          Dolerite  9 1.67e-01 1.00000           ns
## 13 CrystallineQuartz        Fine Chert 85 7.41e-05 0.00156           **
## 14 CrystallineQuartz         Quartzite  7 1.00e+00 1.00000           ns
## 15 CrystallineQuartz         Sandstone  7 1.00e+00 1.00000           ns
## 16          Dolerite        Fine Chert 80 1.00e+00 1.00000           ns
## 17          Dolerite         Quartzite  2 1.00e+00 1.00000           ns
## 18          Dolerite         Sandstone  2 1.00e+00 1.00000           ns
## 19        Fine Chert         Quartzite 78 1.00e+00 1.00000           ns
## 20        Fine Chert         Sandstone 78 1.00e+00 1.00000           ns
## 21         Quartzite         Sandstone  0 1.00e+00 1.00000           ns
## [1] "Showing results of barf and bas"
##               group1            group2  n     p p.adj p.adj.signif
## 1              Agate       CoarseChert 10 1.000     1           ns
## 2              Agate CrystallineQuartz 27 1.000     1           ns
## 3              Agate          Dolerite  1 1.000     1           ns
## 4              Agate        Fine Chert 29 1.000     1           ns
```

```
## 5              Agate         Quartzite  1 1.000     1           ns
## 6              Agate         Sandstone  1 1.000     1           ns
## 7        CoarseChert CrystallineQuartz 35 0.396     1           ns
## 8        CoarseChert          Dolerite  9 1.000     1           ns
## 9        CoarseChert        Fine Chert 37 0.327     1           ns
## 10       CoarseChert         Quartzite  9 1.000     1           ns
## 11       CoarseChert         Sandstone  9 1.000     1           ns
## 12 CrystallineQuartz          Dolerite 26 1.000     1           ns
## 13 CrystallineQuartz        Fine Chert 54 0.724     1           ns
## 14 CrystallineQuartz         Quartzite 26 1.000     1           ns
## 15 CrystallineQuartz         Sandstone 26 1.000     1           ns
## 16          Dolerite        Fine Chert 28 1.000     1           ns
## 17          Dolerite         Quartzite  0 1.000     1           ns
## 18          Dolerite         Sandstone  0 1.000     1           ns
## 19        Fine Chert         Quartzite 28 1.000     1           ns
## 20        Fine Chert         Sandstone 28 1.000     1           ns
## 21         Quartzite         Sandstone  0 1.000     1           ns
## [1] "Showing results of bas and Terrestrial"
##               group1            group2   n p p.adj p.adj.signif
## 1              Agate       CoarseChert  15 1     1           ns
## 2              Agate CrystallineQuartz   9 1     1           ns
## 3              Agate          Dolerite   9 1     1           ns
## 4              Agate        Fine Chert 141 1     1           ns
## 5              Agate         Quartzite   6 1     1           ns
## 6              Agate         Sandstone   6 1     1           ns
## 7        CoarseChert CrystallineQuartz  12 1     1           ns
## 8        CoarseChert          Dolerite  12 1     1           ns
## 9        CoarseChert        Fine Chert 144 1     1           ns
## 10       CoarseChert         Quartzite   9 1     1           ns
## 11       CoarseChert         Sandstone   9 1     1           ns
## 12 CrystallineQuartz          Dolerite   6 1     1           ns
## 13 CrystallineQuartz        Fine Chert 138 1     1           ns
## 14 CrystallineQuartz         Quartzite   3 1     1           ns
## 15 CrystallineQuartz         Sandstone   3 1     1           ns
## 16          Dolerite        Fine Chert 138 1     1           ns
## 17          Dolerite         Quartzite   3 1     1           ns
## 18          Dolerite         Sandstone   3 1     1           ns
## 19        Fine Chert         Quartzite 135 1     1           ns
## 20        Fine Chert         Sandstone 135 1     1           ns
## 21         Quartzite         Sandstone   0 1     1           ns
## [1] "Showing results of bas and barf"
##               group1            group2   n        p    p.adj p.adj.signif
## 1              Agate       CoarseChert  14 5.59e-01 1.00e+00           ns
## 2              Agate CrystallineQuartz  26 5.95e-03 1.19e-01           ns
## 3              Agate          Dolerite   5 1.00e+00 1.00e+00           ns
## 4              Agate        Fine Chert  89 1.00e+00 1.00e+00           ns
## 5              Agate         Quartzite   4 1.00e+00 1.00e+00           ns
## 6              Agate         Sandstone   4 1.00e+00 1.00e+00           ns
## 7        CoarseChert CrystallineQuartz  32 2.42e-02 4.60e-01           ns
## 8        CoarseChert          Dolerite  11 4.55e-01 1.00e+00           ns
## 9        CoarseChert        Fine Chert  95 6.76e-02 1.00e+00           ns
## 10       CoarseChert         Quartzite  10 1.00e+00 1.00e+00           ns
## 11       CoarseChert         Sandstone  10 1.00e+00 1.00e+00           ns
## 12 CrystallineQuartz          Dolerite  23 8.70e-02 1.00e+00           ns
```

```
## 13 CrystallineQuartz        Fine Chert 107 6.15e-09 1.29e-07         ****
## 14 CrystallineQuartz         Quartzite  22 1.00e+00 1.00e+00           ns
## 15 CrystallineQuartz         Sandstone  22 1.00e+00 1.00e+00           ns
## 16          Dolerite        Fine Chert  86 1.00e+00 1.00e+00           ns
## 17          Dolerite         Quartzite   1 1.00e+00 1.00e+00           ns
## 18          Dolerite         Sandstone   1 1.00e+00 1.00e+00           ns
## 19        Fine Chert         Quartzite  85 1.00e+00 1.00e+00           ns
## 20        Fine Chert         Sandstone  85 1.00e+00 1.00e+00           ns
## 21         Quartzite         Sandstone   0 1.00e+00 1.00e+00           ns
## [1] "Showing results of rbl.clbrf and Terrestrial"
##               group1            group2   n        p    p.adj p.adj.signif
## 1              Agate       CoarseChert  15 5.69e-01 1.00e+00           ns
## 2              Agate CrystallineQuartz  27 1.28e-02 2.56e-01           ns
## 3              Agate          Dolerite   6 1.00e+00 1.00e+00           ns
## 4              Agate        Fine Chert 102 1.00e+00 1.00e+00           ns
## 5              Agate         Quartzite   4 1.00e+00 1.00e+00           ns
## 6              Agate         Sandstone   4 1.00e+00 1.00e+00           ns
## 7        CoarseChert CrystallineQuartz  34 2.38e-02 4.28e-01           ns
## 8        CoarseChert          Dolerite  13 4.62e-01 1.00e+00           ns
## 9        CoarseChert        Fine Chert 109 6.77e-02 1.00e+00           ns
## 10       CoarseChert         Quartzite  11 1.00e+00 1.00e+00           ns
## 11       CoarseChert         Sandstone  11 1.00e+00 1.00e+00           ns
## 12 CrystallineQuartz          Dolerite  25 2.00e-02 3.80e-01           ns
## 13 CrystallineQuartz        Fine Chert 121 3.33e-09 6.99e-08         ****
## 14 CrystallineQuartz         Quartzite  23 1.00e+00 1.00e+00           ns
## 15 CrystallineQuartz         Sandstone  23 1.00e+00 1.00e+00           ns
## 16          Dolerite        Fine Chert 100 1.00e+00 1.00e+00           ns
## 17          Dolerite         Quartzite   2 1.00e+00 1.00e+00           ns
## 18          Dolerite         Sandstone   2 1.00e+00 1.00e+00           ns
## 19        Fine Chert         Quartzite  98 1.00e+00 1.00e+00           ns
## 20        Fine Chert         Sandstone  98 1.00e+00 1.00e+00           ns
## 21         Quartzite         Sandstone   0 1.00e+00 1.00e+00           ns
```