Principal Component Analysis (PCA)

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1. Primer paso: cargar las librerias que necesitas.

```
library(ggplot2)
library(dplyr)
library(missMDA) # Imputate
library(ggfortify) # autoplot()
library(cluster) #pam
library(factoextra) #get_pca_var()
library(data.table) # data.table()
library(devtools)

install_github("vqv/ggbiplot") #ggbiplot
library(ggbiplot)
```

2. Segundo paso: cargar los datos.

```
channel <- read.csv("data/channel_form.csv", header=TRUE)
head(channel)
```

```
##      Forma NAN_Am NADBO NAtemp  nit NASatO2 Elevacion Ancho Velocidad Rocas
## 1 Trapecio   0.03  2.38  27.33 0.35   92.04        23    16         5    20
## 2 Trapecio   0.03  2.95  27.81   NA  100.03        31    11         0    20
## 3 Trapecio   0.03  3.13  24.27   NA   96.82        35    14        10    30
## 4 Trapecio   1.15  4.73  27.06 7.54   64.35         9     5         2     0
## 5 Trapecio   0.50  8.16  26.60   NA  110.39        43    11         9    10
## 6 Trapecio   0.53  8.57  23.82   NA  106.09        23    11         5    20
##   Canto grava arena Limo
## 1    25    30    20    0
## 2    45    20    15    0
## 3    30    20    10    0
## 4     0     0    50   50
## 5    40    10    20   20
## 6    60    20     0    0
```

2.1 Vamos a examinar los datos

```
summary(channel)
```

```
##     Forma              NAN_Am          NADBO            NAtemp     
##  Length:138         Min.   :0.0200   Min.   : 1.310   Min.   :14.67  
##  Class :character   1st Qu.:0.0400   1st Qu.: 1.930   1st Qu.:24.30  
##  Mode  :character   Median :0.2150   Median : 3.000   Median :26.05  
##                     Mean   :0.3201   Mean   : 6.164   Mean   :25.84  
##                     3rd Qu.:0.5000   3rd Qu.: 8.585   3rd Qu.:27.70  
##                     Max.   :1.5000   Max.   :34.900   Max.   :32.18  
##                                      NA's   :35                      
##       nit            NASatO2         Elevacion           Ancho       
##  Min.   :  0.00   Min.   : 23.43   Min.   :   3.00   Min.   : 1.000  
##  1st Qu.:  0.40   1st Qu.: 86.24   1st Qu.:  25.25   1st Qu.: 2.000  
##  Median :  0.92   Median : 94.59   Median :  53.00   Median : 3.000  
##  Mean   : 12.00   Mean   : 91.05   Mean   : 230.89   Mean   : 3.822  
##  3rd Qu.:  1.62   3rd Qu.:100.52   3rd Qu.: 269.25   3rd Qu.: 3.000  
##  Max.   :324.11   Max.   :122.73   Max.   :2370.00   Max.   :16.000  
##  NA's   :57                                          NA's   :3       
##    Velocidad          Rocas           Canto           grava     
##  Min.   : 0.000   Min.   : 0.00   Min.   : 0.00   Min.   : 0.0  
##  1st Qu.: 3.000   1st Qu.: 0.00   1st Qu.: 0.00   1st Qu.: 2.5  
##  Median :11.000   Median :10.00   Median :25.00   Median :20.0  
##  Mean   : 9.133   Mean   :16.25   Mean   :25.65   Mean   :17.8  
##  3rd Qu.:14.000   3rd Qu.:30.00   3rd Qu.:40.00   3rd Qu.:25.0  
##  Max.   :16.000   Max.   :90.00   Max.   :80.00   Max.   :80.0  
##  NA's   :3        NA's   :3       NA's   :4       NA's   :3     
##      arena             Limo       
##  Min.   :  0.00   Min.   :  0.00  
##  1st Qu.: 10.00   1st Qu.:  0.00  
##  Median : 15.00   Median : 10.00  
##  Mean   : 19.79   Mean   : 20.62  
##  3rd Qu.: 25.00   3rd Qu.: 25.00  
##  Max.   :100.00   Max.   :100.00  
##  NA's   :3        NA's   :3       
```

2.1 Remover la(s) variable(s) que tiene(n) mucho(s) NAs y las Etiquetas (a la funcion lo le gusta), luego las agregamos.

```
channel_1 <- select(channel, -Forma)
summary(channel_1)
```

```
##      NAN_Am           NADBO            NAtemp           nit         
##  Min.   :0.0200   Min.   : 1.310   Min.   :14.67   Min.   :  0.00  
##  1st Qu.:0.0400   1st Qu.: 1.930   1st Qu.:24.30   1st Qu.:  0.40  
##  Median :0.2150   Median : 3.000   Median :26.05   Median :  0.92  
##  Mean   :0.3201   Mean   : 6.164   Mean   :25.84   Mean   : 12.00  
##  3rd Qu.:0.5000   3rd Qu.: 8.585   3rd Qu.:27.70   3rd Qu.:  1.62  
##  Max.   :1.5000   Max.   :34.900   Max.   :32.18   Max.   :324.11  
##                   NA's   :35                       NA's   :57      
##     NASatO2         Elevacion            Ancho          Velocidad     
##  Min.   : 23.43   Min.   :   3.00   Min.   : 1.000   Min.   : 0.000  
##  1st Qu.: 86.24   1st Qu.:  25.25   1st Qu.: 2.000   1st Qu.: 3.000  
##  Median : 94.59   Median :  53.00   Median : 3.000   Median :11.000  
##  Mean   : 91.05   Mean   : 230.89   Mean   : 3.822   Mean   : 9.133  
##  3rd Qu.:100.52   3rd Qu.: 269.25   3rd Qu.: 3.000   3rd Qu.:14.000  
```

```
##  Max.   :122.73   Max.   :2370.00   Max.   :16.000   Max.   :16.000
##                                     NA's   :3        NA's   :3
##      Rocas           Canto           grava           arena
##  Min.   : 0.00   Min.   : 0.00   Min.   : 0.0   Min.   :  0.00
##  1st Qu.: 0.00   1st Qu.: 0.00   1st Qu.: 2.5   1st Qu.: 10.00
##  Median :10.00   Median :25.00   Median :20.0   Median : 15.00
##  Mean   :16.25   Mean   :25.65   Mean   :17.8   Mean   : 19.79
##  3rd Qu.:30.00   3rd Qu.:40.00   3rd Qu.:25.0   3rd Qu.: 25.00
##  Max.   :90.00   Max.   :80.00   Max.   :80.0   Max.   :100.00
##  NA's   :3       NA's   :4       NA's   :3      NA's   :3
##       Limo
##  Min.   :  0.00
##  1st Qu.:  0.00
##  Median : 10.00
##  Mean   : 20.62
##  3rd Qu.: 25.00
##  Max.   :100.00
##  NA's   :3
```

2.2 Vamos a imputar datos. Esto es comun para set de datos de campo, los cuales tienden a tener ceros (por mal funcionamiento de los equipos, condiciones climticas adversas que no puedemos ir al campo). Se realiza como un paso preliminar para para realizar un PCA en un set de datos completos.

Mas informacion aca: https://www.rdocumentation.org/packages/missMDA/versions/1.18/topics/imputePCA

Primero separar e imputar los datos de sustrato y los fisicoquimicos por aparte.

```
df1 <- select(channel_1, Elevacion, Ancho, Velocidad, Rocas, Canto, grava, arena, Limo)
df1
```

```
##     Elevacion Ancho Velocidad Rocas Canto grava arena  Limo
## 1          23    16         5  20.0  25.0  30.0  20.0   0.0
## 2          31    11         0  20.0  45.0  20.0  15.0   0.0
## 3          35    14        10  30.0  30.0  20.0  10.0   0.0
## 4           9     5         2   0.0   0.0   0.0  50.0  50.0
## 5          43    11         9  10.0  40.0  10.0  20.0  20.0
## 6          23    11         5  20.0  60.0  20.0   0.0   0.0
## 7          86    11        13   0.0  80.0  20.0  20.0   0.0
## 8          26     3        11   0.0  30.0  20.0  25.0  25.0
## 9          24     3        14   5.0  25.0  35.0  20.0  15.0
## 10         53    11         4   0.0  70.0   5.0  20.0   5.0
## 11         24    11         3   0.0  70.0  20.0  10.0   0.0
## 12        619     2        14  30.0  30.0  20.0  20.0   0.0
## 13        598     3        14  20.0  30.0  20.0  10.0  20.0
## 14        583     3        14  20.0  30.0  20.0  10.0  20.0
## 15        114     2        11   0.0  15.0  30.0  25.0  15.0
## 16         46     3        14   0.0   5.0  20.0  40.0  35.0
## 17         46     3        16   0.0   1.0  40.0  40.0  19.0
## 18        158    11         4  40.0  50.0   5.0   5.0   0.0
## 19         34    11         4   0.0  70.0  15.0  15.0   0.0
## 20       1818    NA        NA    NA    NA    NA    NA    NA
## 21        205    11         4   0.0  80.0  10.0  10.0   0.0
## 22         38     3        13   0.0  40.0  30.0  20.0  10.0
```

```
## 23        98     3         14  25.0  25.0  15.0  25.0  10.0
## 24        49     3         15  10.0  60.0  10.0  10.0  10.0
## 25        29     3         14   5.0  25.0  30.0  25.0  15.0
## 26        99     3         14  25.0  40.0   0.0  10.0  25.0
## 27        20     3         14  15.0  15.0   5.0  30.0  35.0
## 28        82     1         11  60.0   0.0  20.0  20.0   0.0
## 29        43     2         11   0.0  50.0  50.0   0.0   0.0
## 30        17     3          2   0.0  33.3  33.3  33.3   0.0
## 31       149     3          3  90.0  10.0   0.0   0.0   0.0
## 32        10     1         14  15.0  20.0  40.0  10.0  15.0
## 33        28     1         14  10.0  70.0  10.0   0.0  10.0
## 34        18     1         12  10.0  20.0  50.0  10.0  10.0
## 35        85     1         14  10.0  20.0  50.0  10.0  10.0
## 36       130     2          2   0.0  30.0   0.0  70.0   0.0
## 37        51     2         10  35.0  50.0   0.0  15.0   0.0
## 38       198     1          3  90.0   0.0   0.0  10.0   0.0
## 39        13     1          3  33.3  33.3   0.0   0.0  33.3
## 40        53     2          3   0.0   0.0  50.0  50.0   0.0
## 41       492     2         14  50.0  20.0  10.0  10.0  10.0
## 42       428     2         14  20.0  40.0  20.0  10.0  10.0
## 43        49     3         11   0.0  10.0  30.0  50.0  10.0
## 44        67     3         12  20.0  40.0  20.0  10.0  10.0
## 45        67     1         11  10.0  60.0  20.0   5.0   5.0
## 46       100     2          9  20.0  35.0  25.0  15.0   5.0
## 47        83     1         14  50.0  30.0  10.0   5.0   5.0
## 48        63     1         12  10.0  60.0  20.0   5.0   5.0
## 49        60     3         12  10.0   5.0   5.0  30.0  50.0
## 50        25     3         11   0.0  70.0  20.0   5.0   5.0
## 51        30     3         11   0.0  10.0  40.0  40.0  10.0
## 52        50     2          3   0.0   0.0   0.0  50.0  50.0
## 53        36     2          3   0.0   0.0  10.0  20.0  70.0
## 54        22     3         11   0.0  20.0  60.0  10.0  10.0
## 55        11     2         12   0.0   0.0  80.0  20.0   0.0
## 56        71     3         14   5.0  50.0  20.0  15.0  10.0
## 57        15     3         12   0.0  10.0  70.0  10.0  10.0
## 58        85     3          9   5.0  60.0  20.0  10.0   5.0
## 59        21     3         11   0.0  10.0  60.0  20.0  10.0
## 60       659     2         13  10.0  70.0  20.0   0.0   0.0
## 61       615     3         14  30.0  30.0  30.0  10.0   0.0
## 62       517     3         14  50.0  30.0  10.0  10.0   0.0
## 63       422     2         14  30.0  40.0  20.0  10.0   0.0
## 64       363     3         14  30.0  40.0  20.0   5.0   5.0
## 65       117     3         14  10.0  70.0  10.0  10.0   0.0
## 66       244     2          9  25.0  30.0  25.0  15.0   5.0
## 67        15     2         11   0.0   0.0  40.0  40.0  20.0
## 68        22     3         14  10.0  40.0  30.0  15.0   5.0
## 69      1114     1         10  75.0  15.0   0.0  10.0   0.0
## 70       353     1         14  40.0  20.0  20.0  20.0   0.0
## 71       314     1         14  50.0  10.0  20.0  20.0   0.0
## 72      1630     1         14  30.0  25.0  25.0   0.0  20.0
## 73       628     1         14  30.0  20.0  20.0  20.0  10.0
## 74       137     1         14  20.0  60.0  10.0  10.0   0.0
## 75        51     2         14  30.0  25.0  25.0   0.0  20.0
## 76        27     2          8  40.0  30.0  20.0  10.0   0.0
```

```
## 77           27    12         0   0.0   0.0  15.0  85.0   0.0
## 78           15    12         0   0.0   0.0  10.0  90.0   0.0
## 79           16    12         0   0.0   0.0  20.0  80.0   0.0
## 80           15     5         2   0.0   0.0   0.0  50.0  50.0
## 81            6    11         2   0.0   0.0   0.0  50.0  50.0
## 82            3    11         2   0.0   0.0   0.0  50.0  50.0
## 83           10    11         2   0.0   0.0   0.0  50.0  50.0
## 84            8    11         2   0.0   0.0   0.0   0.0 100.0
## 85           86    11         4   0.0  65.0  20.0  10.0   5.0
## 86           26    11         2   0.0   0.0   0.0  50.0  50.0
## 87            9     2        11   0.0   0.0   0.0   0.0 100.0
## 88           28     5         2   0.0    NA  80.0  10.0  10.0
## 89           27     5         1   0.0   0.0  60.0  20.0  20.0
## 90           21     3        11   0.0   0.0   0.0  40.0  60.0
## 91           13     3         2   0.0   0.0   0.0  20.0  80.0
## 92           23     3         2   0.0   0.0   0.0  50.0  50.0
## 93           23     3         2   0.0   0.0   0.0   0.0 100.0
## 94           11     3         2   0.0   0.0   0.0   0.0 100.0
## 95           27     2         3   0.0   0.0   0.0   0.0 100.0
## 96           19     2         2   0.0   0.0   0.0   0.0 100.0
## 97           43     1         2   0.0   0.0   0.0   0.0 100.0
## 98           46     2         3   0.0   0.0  10.0   0.0  90.0
## 99           44     3        12   0.0   0.0   0.0   0.0 100.0
## 100          53     2        14   0.0  15.0   5.0  15.0  65.0
## 101          42     3         2   0.0   0.0   0.0   0.0 100.0
## 102          50     3         2   0.0   0.0   0.0  15.0  85.0
## 103          42     2         2   0.0   0.0   0.0   5.0  95.0
## 104          58     3        12   0.0   0.0   0.0  50.0  50.0
## 105          43     2         3   0.0   0.0   0.0 100.0   0.0
## 106          51     2        11   0.0   0.0  50.0  50.0   0.0
## 107          15     3         2   0.0   0.0   0.0  50.0  50.0
## 108          22     2        11   0.0   0.0   0.0  50.0  50.0
## 109          13     2        11   0.0   5.0  35.0  30.0  30.0
## 110         115     5         9   0.0  80.0  10.0  10.0   0.0
## 111         491     2        14  35.0  20.0   0.0  35.0  10.0
## 112         524     3        14  40.0  30.0  20.0  10.0   0.0
## 113          98     2        14  25.0  30.0  25.0  15.0   5.0
## 114         275    NA        NA    NA    NA    NA    NA    NA
## 115        1488     2        14  20.0  40.0  20.0  10.0  10.0
## 116         196     2        15  35.0  40.0  10.0  10.0   5.0
## 117         291     2        11  30.0  30.0  20.0  15.0   5.0
## 118         223    11         5  40.0  50.0   5.0   5.0   0.0
## 119        1346    NA        NA    NA    NA    NA    NA    NA
## 120        2370     2        15  25.0  25.0  35.0  10.0   5.0
## 121          17    11         4  30.0  40.0  10.0  10.0  10.0
## 122        1412     2        15  35.0  40.0  15.0  10.0   0.0
## 123         490     2        15  20.0  30.0  35.0  15.0   0.0
## 124         252     3        15  25.0  30.0  30.0  15.0   0.0
## 125         162     2        14  15.0  20.0  15.0  25.0  25.0
## 126         494     2        15  45.0  25.0  10.0  15.0   5.0
## 127         428     2        15  55.0  30.0   5.0   5.0   5.0
## 128         358     1         4  30.0  60.0   0.0  10.0   0.0
## 129         363     1         3  10.0  40.0  25.0  25.0   0.0
## 130         371     2         6  25.0  25.0  20.0  20.0  10.0
```

```
## 131      1420     1         5  40.0  40.0  10.0  10.0   0.0
## 132       828     1         4  40.0  40.0  10.0  10.0   0.0
## 133       952     1        14  50.0  20.0  20.0  10.0   0.0
## 134       422     2        13  30.0  40.0  20.0  10.0   0.0
## 135       144     3        15  50.0  30.0  10.0   5.0   5.0
## 136       200     3        14  15.0  30.0  30.0  20.0   5.0
## 137       327     2        13  40.0  30.0  20.0   8.0   2.0
## 138        60     3        15  30.0  25.0  10.0  30.0   5.0
```

```
df1a <- imputePCA(df1,ncp=4, scale = TRUE, method = c("Regularized","EM"),
                      row.w = NULL, ind.sup=NULL,quanti.sup=NULL,quali.sup=NULL,
                      coeff.ridge = 1, threshold = 1e-06, seed = NULL, nb.init = 1,
                      maxiter = 1000)


df2 <- select(channel_1, Elevacion, NAN_Am, NAtemp, NASatO2, nit, NADBO)
df2a <- imputePCA(df2, ncp=4, scale = TRUE, method = c("Regularized","EM"),
                      row.w = NULL, ind.sup=NULL,quanti.sup=NULL,quali.sup=NULL,
                      coeff.ridge = 1, threshold = 1e-06, seed = NULL, nb.init = 1,
                      maxiter = 1000)
```

Unir las dos tablas y seleccionar las columnas para hacer el PCA.

```
df1b <- as.data.frame(df1a) # Sustrata
df2b <- as.data.frame(df2a) # Physicochemical


new_channel <- do.call("merge", c(lapply(list(df1b, df2b), data.frame, row.names=NULL),
  by = 0, all = TRUE, sort = FALSE))[-1]

new_channel2 <- select(new_channel,
                       completeObs.Elevacion.x, completeObs.Ancho, completeObs.Velocidad,
                       completeObs.Rocas, completeObs.Canto, completeObs.grava, completeObs.arena,
                       completeObs.Limo, completeObs.NAN_Am, completeObs.NAtemp, completeObs.NASatO2,
                       )
```

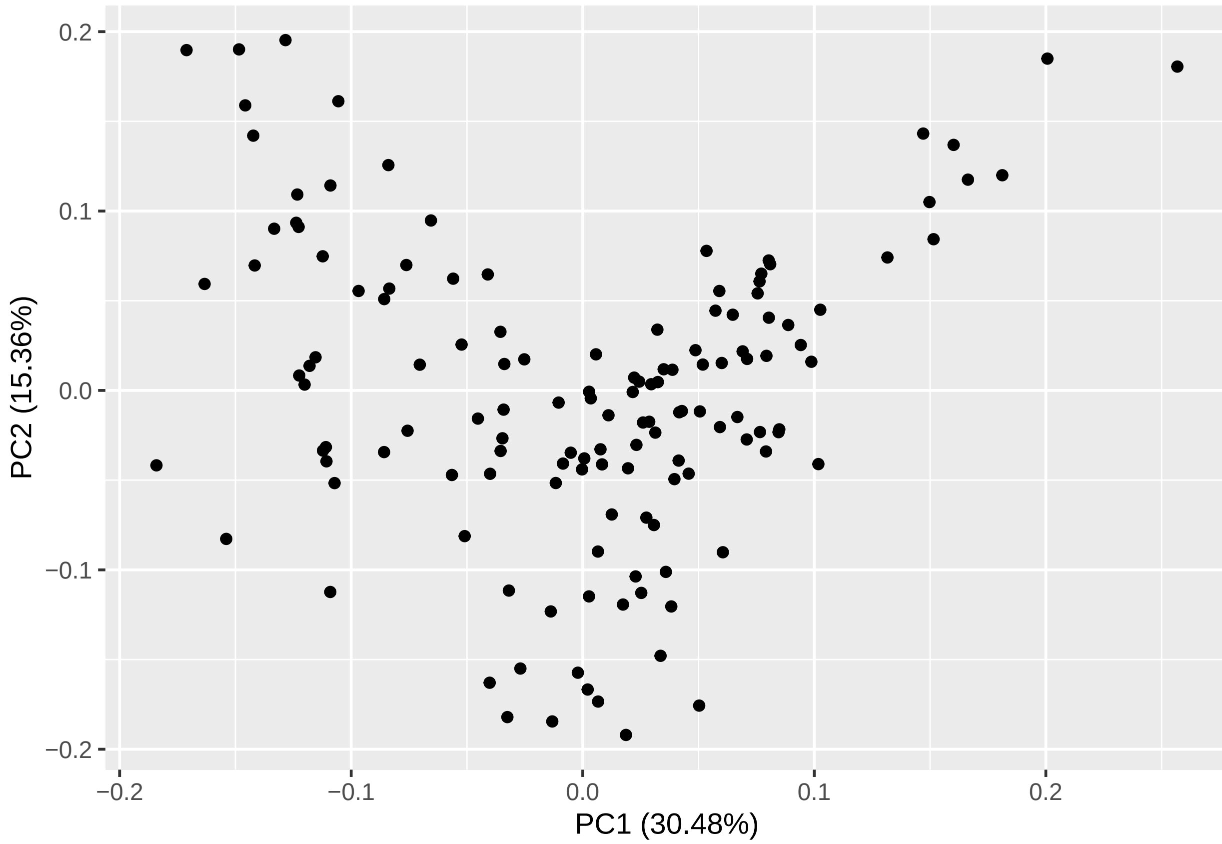
3. Vamos a correr el PCA

```
channel.pca <- prcomp(new_channel2, center = TRUE, scale = TRUE)
summary(channel.pca)
```

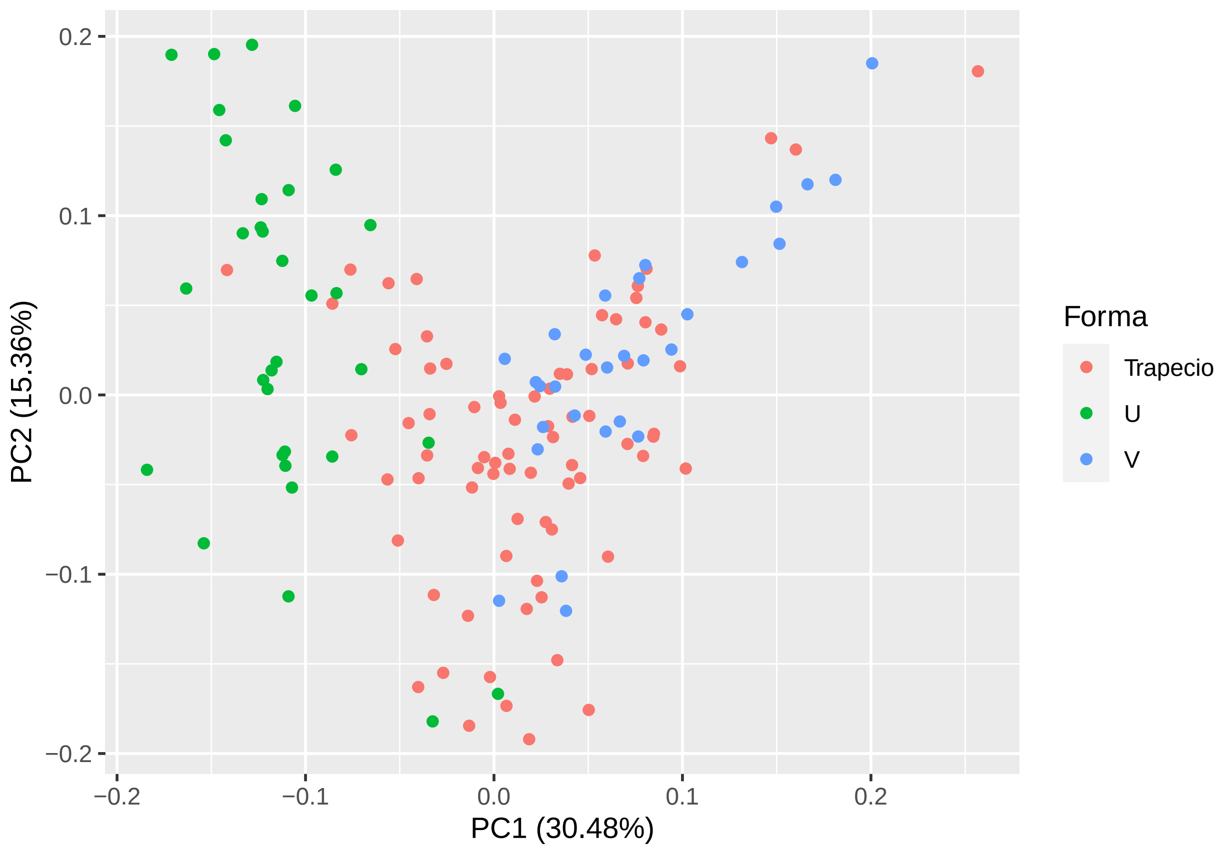
```
## Importance of components:
##                           PC1    PC2    PC3    PC4     PC5     PC6    PC7
## Standard deviation     1.8310 1.2998 1.1999 1.1198 1.00418 0.86855 0.7505
## Proportion of Variance 0.3048 0.1536 0.1309 0.1140 0.09167 0.06858 0.0512
## Cumulative Proportion  0.3048 0.4584 0.5893 0.7033 0.79493 0.86351 0.9147
##                            PC8    PC9    PC10    PC11
## Standard deviation     0.66944 0.5896 0.36998 0.07393
## Proportion of Variance 0.04074 0.0316 0.01244 0.00050
## Cumulative Proportion  0.95546 0.9871 0.99950 1.00000
```

3.1 Vamos a ver el grafico.

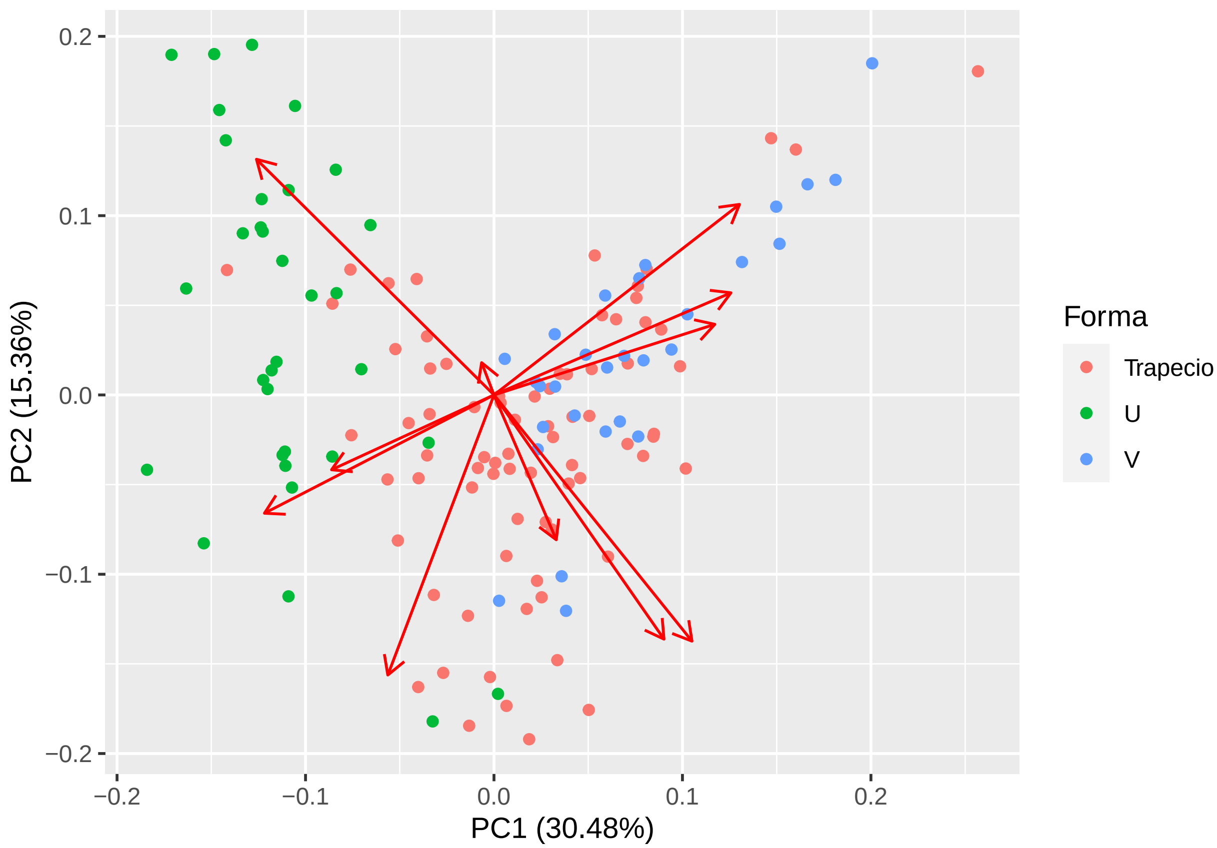
```r
autoplot(channel.pca)
```



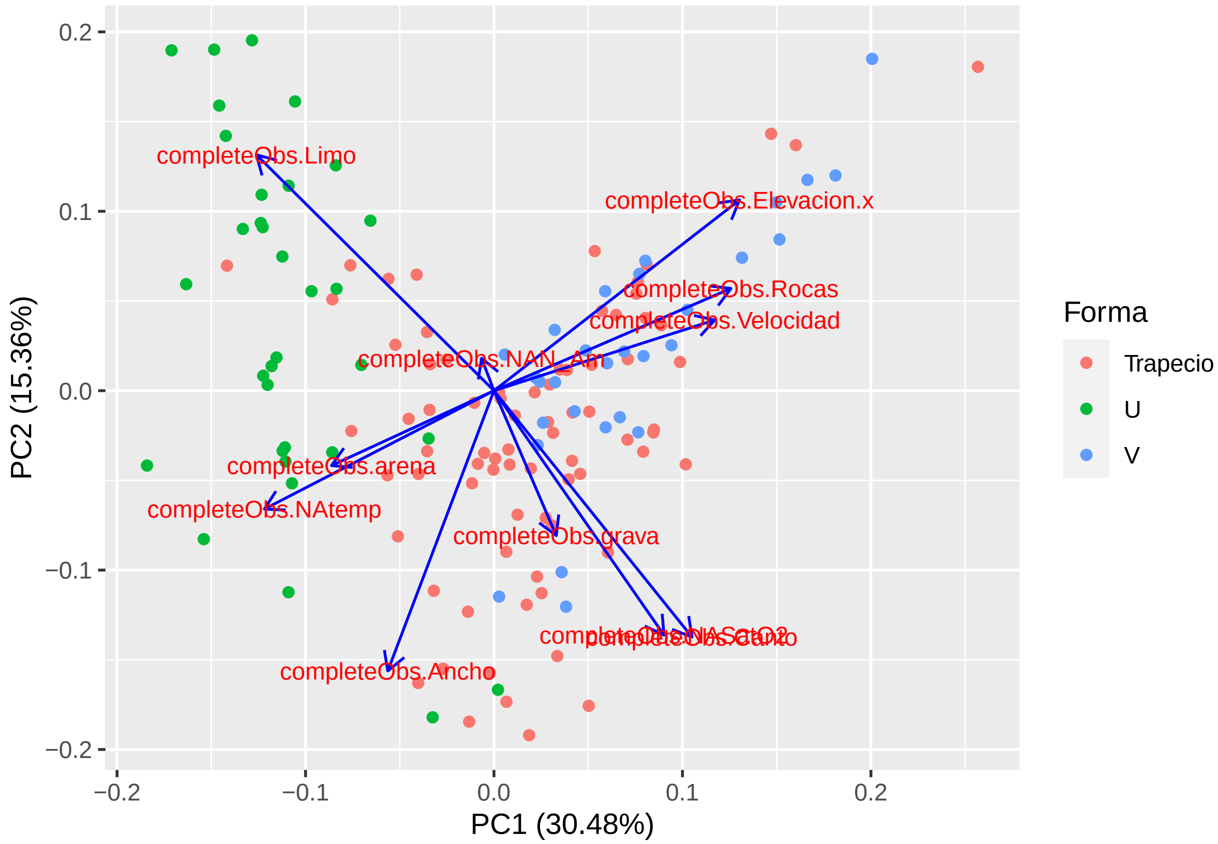

```r
autoplot(channel.pca, data = channel, colour = 'Forma')
```




```r
autoplot(channel.pca, data = channel, colour = 'Forma', loadings = TRUE)
```

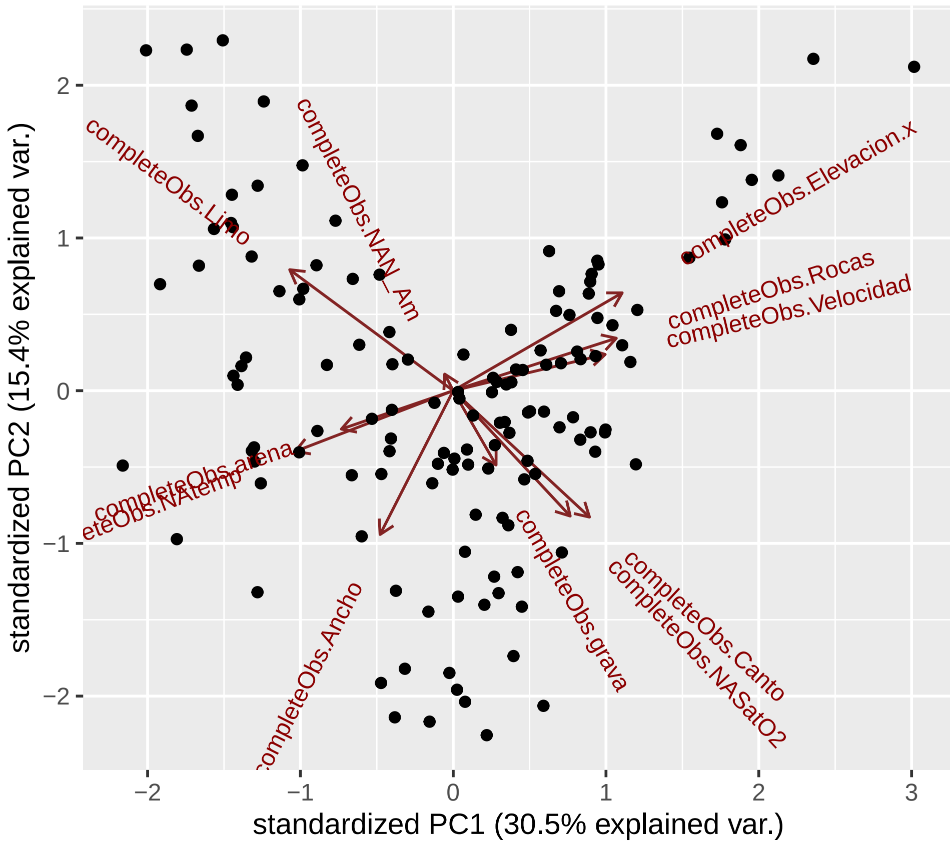



```r
autoplot(channel.pca, data = channel, colour = 'Forma', loadings = TRUE,
         loadings.colour = 'blue',
         loadings.label = TRUE, loadings.label.size = 3)
```



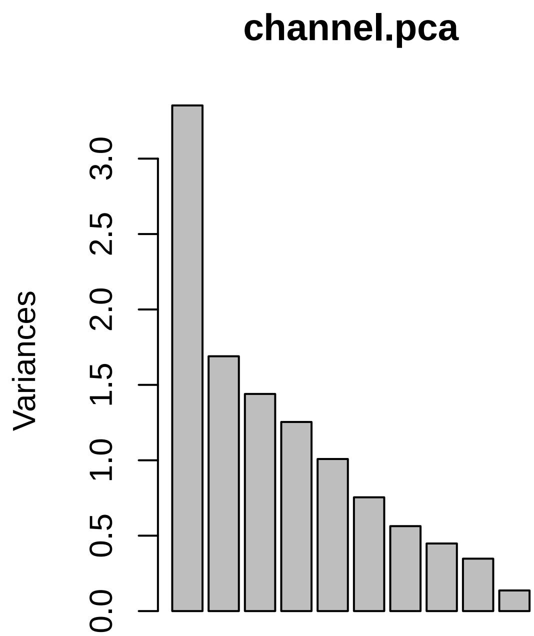
Otra manera de ver el grafico

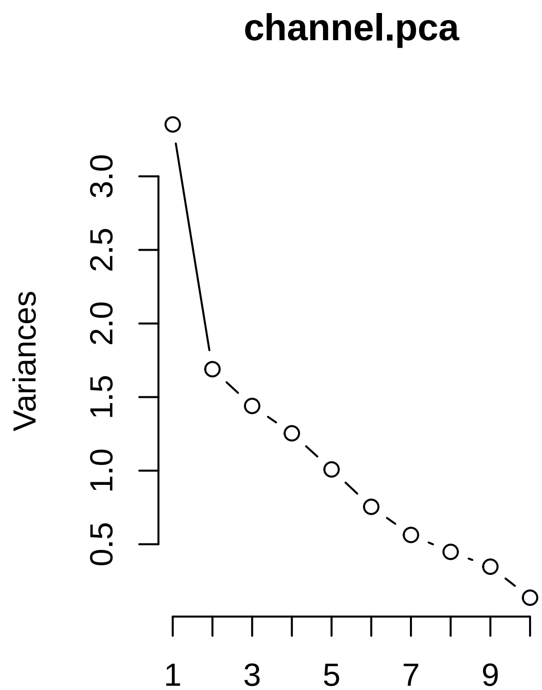
```
ggbiplot(channel.pca, labels=rownames(channel$Forma))
```



3.2 Ver graficamente lo que explica cada axis.

```
layout(matrix(1:2, ncol=2))
screeplot(channel.pca)
screeplot(channel.pca, type="lines")
```





3.3 Vamos a ver la contribucion de cada una de las variables. Usamos otra libreria. factoextra

```
get_eigenvalue(channel.pca)
```

```
##         eigenvalue variance.percent cumulative.variance.percent
## Dim.1  3.352694699      30.47904272                    30.47904
## Dim.2  1.689508243      15.35916585                    45.83821
## Dim.3  1.439800174      13.08909249                    58.92730
## Dim.4  1.253869419      11.39881290                    70.32611
## Dim.5  1.008381966       9.16710878                    79.49322
## Dim.6  0.754372229       6.85792936                    86.35115
## Dim.7  0.563247051       5.12042774                    91.47158
## Dim.8  0.448148987       4.07408170                    95.54566
## Dim.9  0.347624920       3.16022655                    98.70589
## Dim.10 0.136887037       1.24442761                    99.95032
## Dim.11 0.005465274       0.04968431                   100.00000
```

```
res.var <- get_pca_var(channel.pca)
res.var$contrib        # Contributions to the PCs
```

```
##                               Dim.1      Dim.2      Dim.3      Dim.4      Dim.5
## completeObs.Elevacion.x 15.69107929 10.4466821  5.9219155  3.4547410  0.8439586
## completeObs.Ancho        2.93657638 22.5709558 21.8800861  0.1927255  1.1173038
## completeObs.Velocidad   12.69723487  1.4357017 13.6970457  3.2002668  1.8093099
## completeObs.Rocas       14.61820114  3.0028099  2.4269290  2.8550887  1.3185713
```

```
## completeObs.Canto       10.20585820 17.4397796  0.1354289  5.3659433 10.9646203
## completeObs.grava        1.00964779  6.0328282 29.6101644 17.9014051  0.3393758
## completeObs.arena        6.87206684  1.6111116  3.3614213 19.6594247 32.7682152
## completeObs.Limo        14.68913272 15.9788871  0.1991168  5.8519178  5.6759552
## completeObs.NAN_Am       0.03983344  0.3004174  6.7569872 29.6071241 37.0764738
## completeObs.NAtemp      13.71830217  4.0260781 15.8320253  2.7816006  2.0424647
## completeObs.NASatO2      7.52206717 17.1547485  0.1788798  9.1297624  6.0437514
##                             Dim.6       Dim.7        Dim.8        Dim.9
## completeObs.Elevacion.x 10.000533  0.17003373  1.153905614  3.416252440
## completeObs.Ancho        3.047246  5.39949043  0.008628805 37.679642113
## completeObs.Velocidad    4.259844 21.57475837  0.298693085 39.546596378
## completeObs.Rocas       27.829227 24.74347205  4.325934827  1.530179094
## completeObs.Canto        4.682487 11.78377084 13.029281263  6.358299715
## completeObs.grava       10.856698 20.36017545  2.724413288  0.003849738
## completeObs.arena        4.404139 13.37857437  1.075975929  0.591049015
## completeObs.Limo         2.443909  0.62916739 16.702089400  1.473485410
## completeObs.NAN_Am      13.623072  0.02817168  5.829961037  6.130548562
## completeObs.NAtemp      15.025805  0.99138811  1.058190774  1.922503373
## completeObs.NASatO2      3.827041  0.94099758 53.792925978  1.347594162
##                              Dim.10       Dim.11
## completeObs.Elevacion.x 48.86402263 3.687580e-02
## completeObs.Ancho        5.16635651 9.890305e-04
## completeObs.Velocidad    1.45681693 2.373276e-02
## completeObs.Rocas        0.12815440 1.722143e+01
## completeObs.Canto        0.07719300 1.995734e+01
## completeObs.grava        0.45958858 1.070185e+01
## completeObs.arena        0.53751051 1.574051e+01
## completeObs.Limo         0.10397840 3.625236e+01
## completeObs.NAN_Am       0.60560204 1.808434e-03
## completeObs.NAtemp      42.56155517 4.008708e-02
## completeObs.NASatO2      0.03922182 2.300968e-02
```

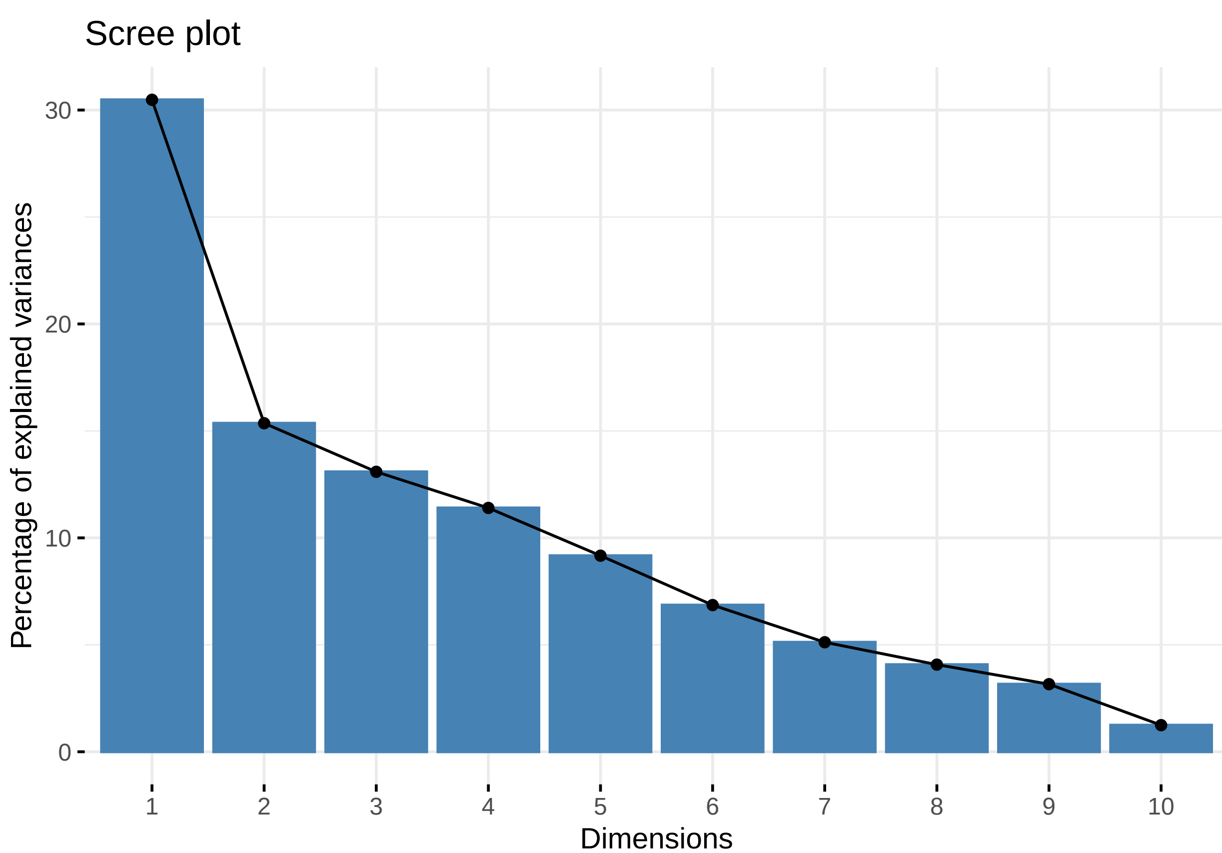
```
res.var$coord          # Coordinates
```

```
##                              Dim.1       Dim.2       Dim.3       Dim.4
## completeObs.Elevacion.x  0.7253096  0.42011612 -0.29199957  0.20812962
## completeObs.Ancho       -0.3137745 -0.61752584 -0.56127490  0.04915818
## completeObs.Velocidad    0.6524565  0.15574434  0.44408342  0.20031766
## completeObs.Rocas        0.7000740  0.22523925 -0.18693028 -0.18920646
## completeObs.Canto        0.5849541 -0.54281352 -0.04415774 -0.25938759
## completeObs.grava        0.1839848 -0.31925715  0.65293736  0.47377235
## completeObs.arena       -0.4799994 -0.16498443 -0.21999489  0.49649120
## completeObs.Limo        -0.7017705  0.51958119 -0.05354329 -0.27087895
## completeObs.NAN_Am      -0.0365444  0.07124308  0.31190882 -0.60929030
## completeObs.NAtemp      -0.6781834 -0.26080821  0.47744060 -0.18675556
## completeObs.NASatO2      0.5021872 -0.53835944 -0.05074950 -0.33834198
##                               Dim.5      Dim.6       Dim.7        Dim.8
## completeObs.Elevacion.x -0.09225143  0.2746657  0.03094689 -0.071911170
## completeObs.Ancho        0.10614466  0.1516165  0.17439172  0.006218513
## completeObs.Velocidad    0.13507314 -0.1792626 -0.34859603 -0.036586747
## completeObs.Rocas       -0.11530930 -0.4581877  0.37331873  0.139235890
## completeObs.Canto        0.33251354  0.1879451 -0.25762714  0.241641453
## completeObs.grava       -0.05849961  0.2861816  0.33864153 -0.110496292
## completeObs.arena       -0.57482934 -0.1822734 -0.27450761  0.069440444
```

```
## completeObs.Limo         0.23923902  0.1357799 -0.05952955 -0.273587727
## completeObs.NAN_Am      -0.61145112  0.3205755 -0.01259667  0.161638211
## completeObs.NAtemp       0.14351253 -0.3366757  0.07472593  0.068864151
## completeObs.NASatO2     -0.24686859 -0.1699121 -0.07280207 -0.490991296
##                               Dim.9       Dim.10        Dim.11
## completeObs.Elevacion.x -0.10897589  0.258628136  0.0014196350
## completeObs.Ancho        0.36191688  0.084095614 -0.0002324935
## completeObs.Velocidad    0.37077463  0.044656394 -0.0011388856
## completeObs.Rocas        0.07293342 -0.013244877 -0.0306789589
## completeObs.Canto       -0.14867089  0.010279456 -0.0330260995
## completeObs.grava       -0.00365823 -0.025082209 -0.0241844096
## completeObs.arena       -0.04532807  0.027125306 -0.0293302253
## completeObs.Limo         0.07156956  0.011930337 -0.0445116939
## completeObs.NAN_Am       0.14598395  0.028792198 -0.0003143817
## completeObs.NAtemp      -0.08175023  0.241373676  0.0014801584
## completeObs.NASatO2     -0.06844394  0.007327318  0.0011214018
```

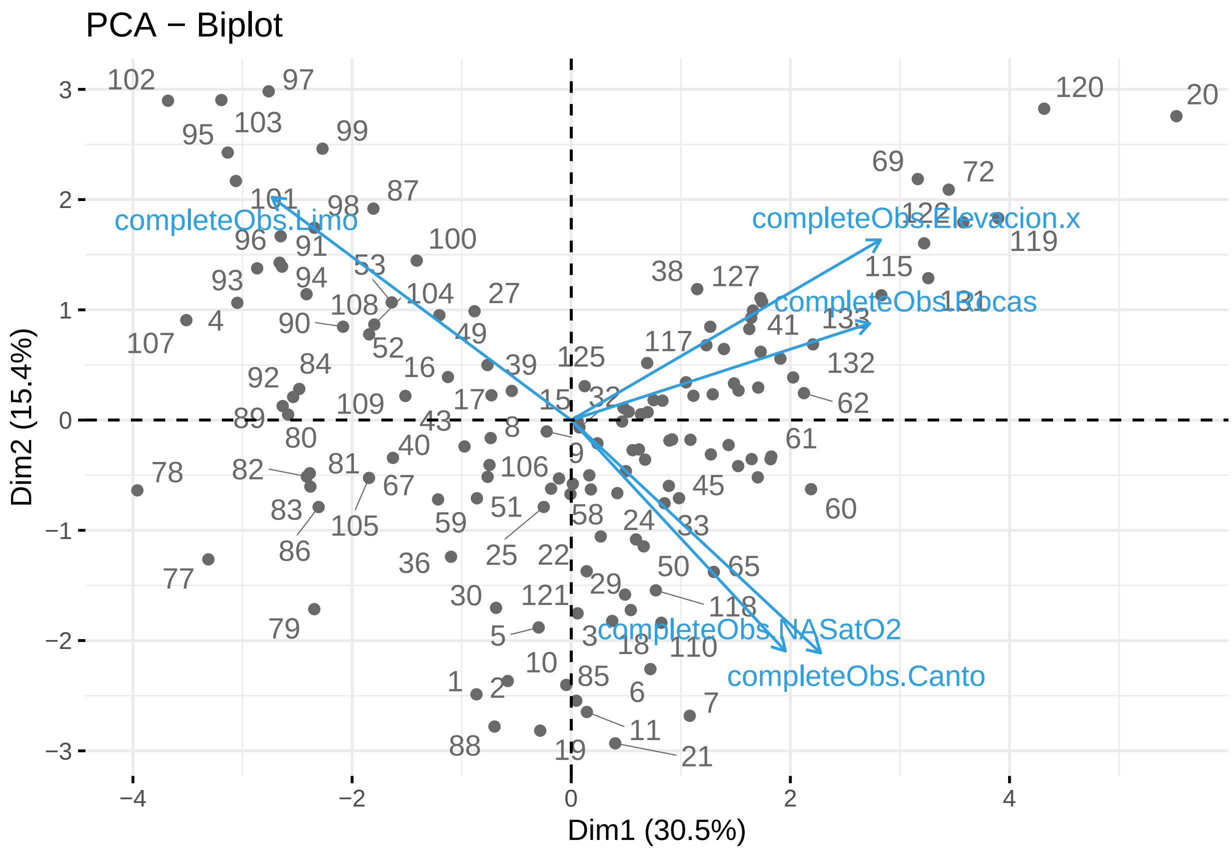
4 Otras formas de visualizar los datos.

```
fviz_eig(channel.pca)
```



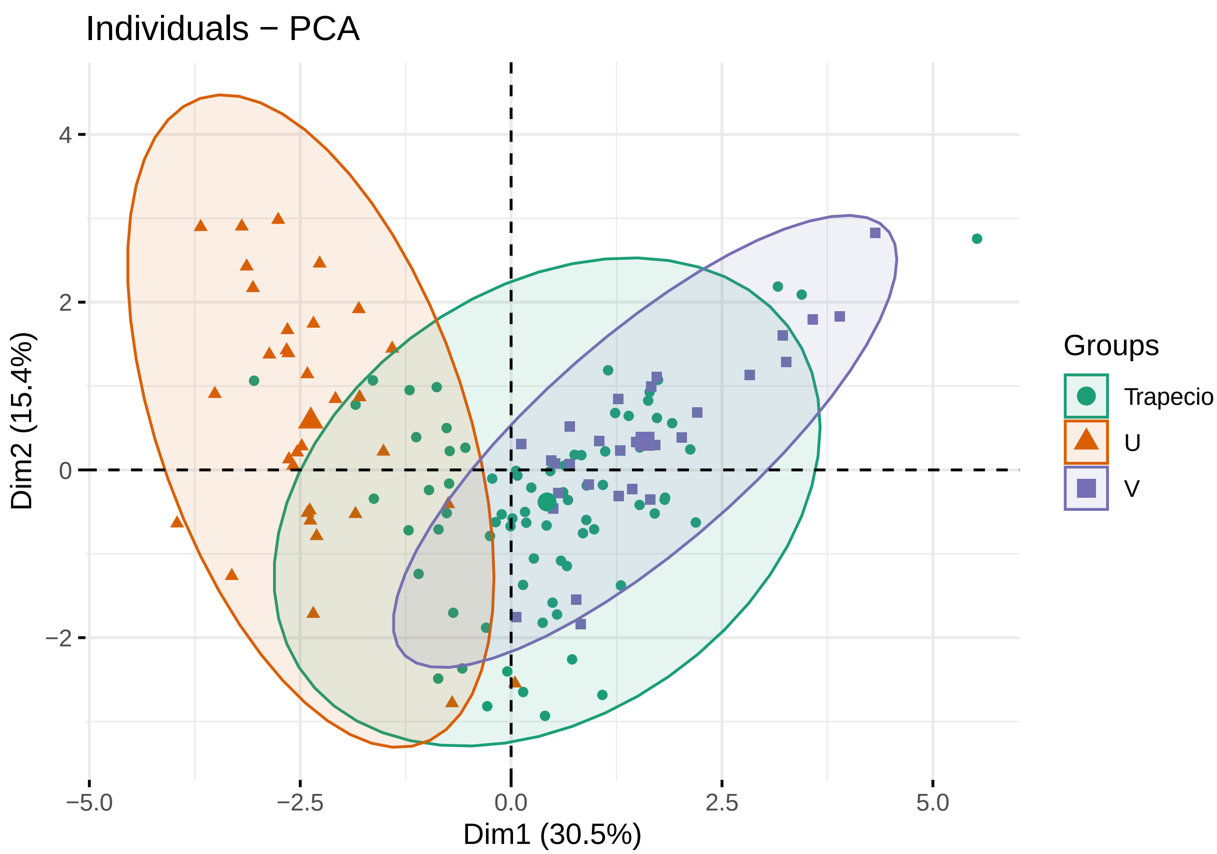

```
fviz_pca_biplot(channel.pca, repel = TRUE,
                col.var = "#2E9FDF", # Variables color
                col.ind = "#696969",  # Individuals color
                select.var = list(contrib = 5))
```

```
## Warning: ggrepel: 45 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```



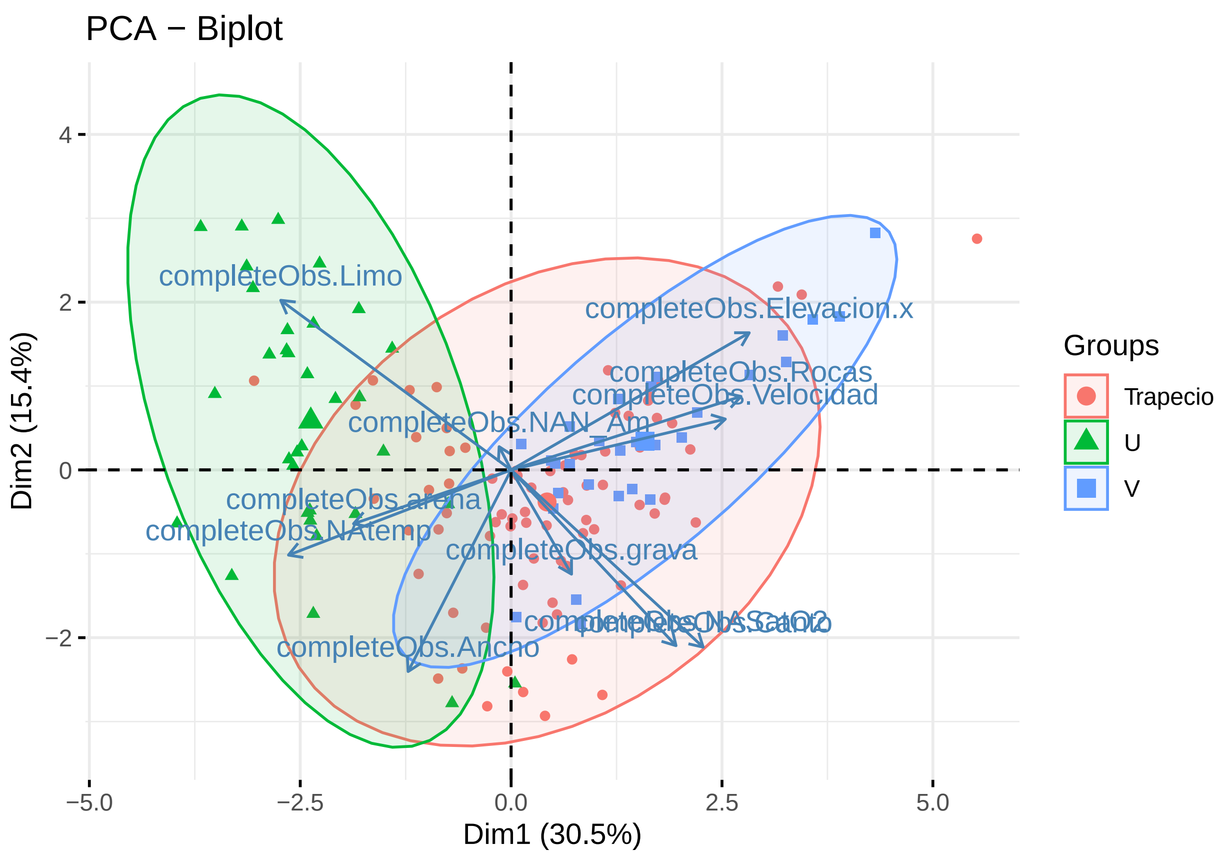
4.1 Con las elipses.

```r
fviz_pca_ind(channel.pca, label="none", habillage=channel$Forma,
     addEllipses=TRUE, ellipse.level=0.95, palette = "Dark2")
```



4.1

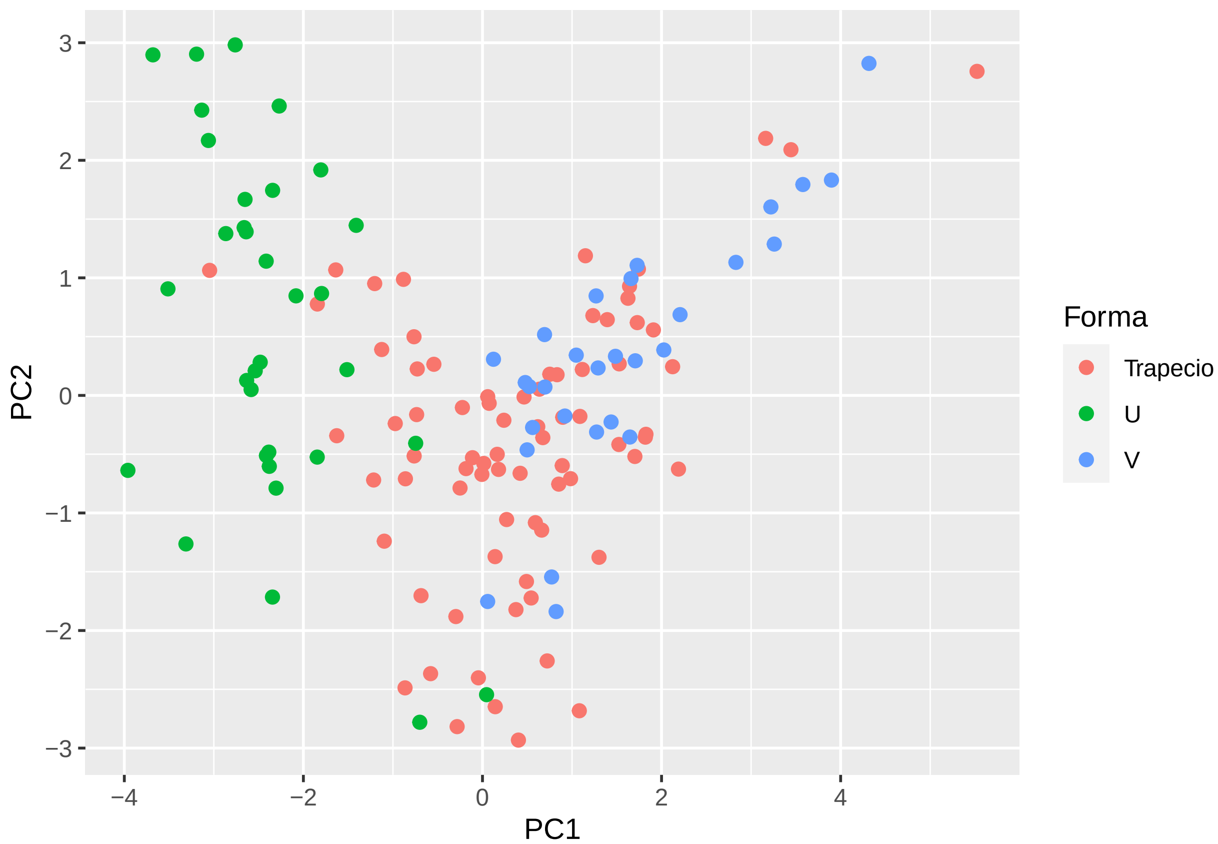
```
fviz_pca_biplot(channel.pca, label = "var", habillage=channel$Forma,
                addEllipses=TRUE, ellipse.level=0.95,
                ggtheme = theme_minimal())
```



5. Convertirlo en una data.frame para trabajarlo en ggplot2

```
data <- data.table(PC1=channel.pca$x[,1], PC2=channel.pca$x[,2], Forma=  channel[,1])
data <- data[order(channel$Forma),]

ggplot(data, aes(x=PC1,y=PC2)) +
  geom_point(size = 2, aes(color=Forma))
```



3
2
1
0
−1
−2
−3
PC2
−4
−2
0
2
4
PC1
Forma
Trapecio
U
V