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% Program OHDCODEBL
% Update 1/27/2018
% Obsidian hydration analysis code baseline. Computes age in cyb2k, age
accuracy,
% and PE of the mean.
% Characteristics: Matrix I/O, lines 27 and 219.
% EHT by numerical integration for current conditions in SW Great
Basin.
% Computes activation energy from inferred water content.
% Uses flow-specific hydration rates for Coso obsidian.
% Rates updated per SCA2013 paper.
% Rates for BH-E, BH-W, CDSR, CDLM, NGM, FS, and Queen added.
% Diurnal variation amplitude represented by cosine model.
%
%**********************************************************************
%
% Module 1 - set constants
clear
% Uncertainty model for error sources
CVKE = 0.05; % CV of estimated hydration rate
YBZ = 0.5; % Default value of fraction of time artifact was at depth
SIGEHT = 1.0; % Std dev of EHT error, deg C
EHTR = 20.0; % Reference EHT for hydration rates, deg C
EHTRK = EHTR + 273.15; % Reference EHT for hydration rates, deg K
%
%**********************************************************************
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%
% Module 2 - Read input data from a .csv file
INDATA = csvread('C:\MATLAB701\work\LBIn.csv');
L = size(INDATA,1);
for jj = 1:L % j is index for sequence number.
   No  = INDATA(jj,1); %No =  Sequence Number
   alt = INDATA(jj,2); %alt = Altitude of archaeological site, ft
   rim = INDATA(jj,3); %rim = Uncorrected rim thickness, microns
   sig = INDATA(jj,4); %sig = Rim standard deviation, microns
   z   = INDATA(jj,5); %z   = Burial depth of artifact, meters
   NS  = INDATA(jj,6); %NS =  Sample size
   FL  = INDATA(jj,7); %FL =  Obsidian source flow:
SLM=1,WSL=2,WCP=3,JRR=4,BH = 5,
   % CDSR = 6, CDLM = 7, Queen =8, NGM = 9, FS = 10
   NOM = INDATA(jj,8); % Nominal condition flag; 1 = surface, 2 =
mixed, 3 = depth
%
%**********************************************************************
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%
% Module 3 - Compute obsidian parameters from hydration rate
%
% Parameters for aggregate Coso volcanic field
ratecal = 22.86; % Default rate for Coso volcanic field, u^2/1000 yrs @
20 deg C
CVKS = 0.33;
% Set parameters for individual flows
    if FL == 1 % SLM
        ratecal = 29.87;
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        CVKS = .13;
    end
    if FL == 2 % WSL
        ratecal = 18.14;
        CVKS = .20;
    end
    if FL == 3 % WCP
        ratecal = 27.28;
        CVKS = .25;
    end
    if FL == 4 % JRR
        ratecal = 22.27;
        CVKS = .26;
    end
    if FL == 5 % Bodie Hills
        ratecal = 14.2;
        CVKS = .15;
    end
    if FL == 6 % Casa Diablo Sawmill Ridge
        ratecal = 12.37;
        CVKS = .15;
    end
    if FL == 7 % Casa Diablo Lookout Mtn
        ratecal = 12.05;
        CVKS = .15;
    end
    if FL == 8 % Queen
        ratecal = 10.29;
        CVKS = .15;
    end
    if FL == 9 % Napa Glass Mtn
        ratecal = 12.05;
        CVKS = .1;
     end
     if FL == 10 % Fish Springs
        ratecal = 11.26;
        CVKS = .15;
     end
ageconst = 1000/ratecal;
% Compute water concentration
water = (log(ratecal)-(37.76-10433/EHTRK))/(-2.289+1023/EHTRK);
% Compute E/R
EoverR = 10433-1023*water; % deg K
%
%*********************************************************************
%
% Module 4 - Temperature model
% Compute temperature parameters for site.
    STA   = 22.71 - 0.002*alt; % Annual Average temperature
    SVA   = 24.25 - 0.0006*alt; % Annual temperature variation, surface
    SVDM  = 18.49 - 0.0007*alt; % Mean diurnal variation, surface
    SVDAM = 2.08; % Amplitude of diurnal variation, surface.
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%***********************************************************************
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% Module 5 - Compute Keff and EHT
% Surface conditions
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DIUP = 2*pi/24; %diurnal period in radians/hour
ANNP = 2*pi/(24*365); % annual period in radians/hour
Nyears = 1; % Length of integration period, years
MM = Nyears*365*24; % Number of data points to integrate
Kint = 0;
for I = 1:MM
   SVD = SVDM + SVDAM*cos(ANNP*I);
   k = exp(-EoverR/((STA+273.15) + (0.5*SVD*cos(DIUP*I))+
(0.5*SVA*cos(ANNP*I))));
   Kint = Kint + k;
end
Keffsurf = Kint/MM;
EHTKS = -EoverR/(log(Keffsurf)); % EHT in deg K at surface
EHTCS = EHTKS - 273.15; % EHT at surface in deg C
% Compute Keff and EHT at artifact depth
SVAB = SVA*exp(-0.44*z); % Annual variation @ artifact recovery depth
Kint = 0;
for I = 1:MM
   SVDB = (SVDM + SVDAM*cos(ANNP*I))*exp(-8.5*z); % Diurnal variation @
artifact recovery depth
   k = exp(-EoverR/((STA+273.15) + (0.5*SVDB*cos(DIUP*I))+
(0.5*SVAB*cos(ANNP*I))));
   Kint = Kint + k;
end
Keff = Kint/MM;
EHTKD = -EoverR/(log(Keff)); % EHT at artifact depth, deg K
EHTCD = EHTKD-273.15; % EHT at artifact depth, deg C
% Compute effective K and EHT for artifact buried YB fraction of its
life.
Keffaverage = (1-YBZ)*Keffsurf+YBZ*Keff;
EHTKA = -EoverR/log(Keffaverage); % Average EHT, deg K
%
%*********************************************************************
%
% Module 6 - Age computation
TEMPFACR = EoverR/EHTRK; % Temperature factor, reference conditions
% Surface conditions
TEMPFACS = EoverR/EHTKS; % Temperature factor
RCFS = exp((-TEMPFACR+TEMPFACS)/2); %Rim correction
rimprimeS = rim*RCFS; % Rim corrected to rate EHT
t1S = ageconst*rimprimeS^2; % Age
% Conditions at depth
TEMPFACD = EoverR/EHTKD; % Temperature factor
RCFD = exp((-TEMPFACR+TEMPFACD)/2); % Rim correction
rimprimeD = rim*RCFD; %Rim corrected to reference EHT
t1D = ageconst*rimprimeD^2; % Age
% Conditions for artifact buried YB fraction of time
TEMPFACA = EoverR/EHTKA; % Temperature factor
RCFA = exp((-TEMPFACR+TEMPFACA)/2); % Rim correction factor
rimprimeA = rim*RCFA; % Rim corrected to reference EHT
t1A = ageconst*rimprimeA^2; % Age
% EHT corrected rim SD
SDprime = sig*RCFA;
%
%*******************************************************************
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% Module 7 - Source/process model standard deviation
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Labvar = 0;
EHTvar = 0;
Watervat = 0;
Ratevar = 0;
SFvar = 0;
if rim > 0
   Labvar = 4*(sig/rim)^2; % Error variance due to rim reading
   EHTvar = 4* (0.06*SIGEHT)^2; % Error variance due to EHT uncertainty
   Watervar = CVKS^2; % Error variance due to intrinsic water
variations
   Ratevar = 4*CVKE^2; % Error variance due to ascribed rate
   SFvar = ((t1S-t1D)^2)/12; % Age uncertainty variance due to site
formation processes
end
% Select which case to use as nominal - surface, mixed, or depth
% Default is mixed (NOM = 2)
t1N = t1A;
if NOM == 1
    t1N = t1S;
end
if NOM == 3
   t1N = t1D;
end
MODSD = sqrt((Labvar+EHTvar+Watervar+Ratevar)*t1N^2+SFvar); %
Source/process model standard deviation
%
%*********************************************************************
*
%
% Module 8 - Output data as .csv file
OUTDATA(jj,1) = No; % sequence no.
OUTDATA(jj,2) = alt; % site altitude, ft
OUTDATA(jj,3) = STA; % Annual temp, deg C
OUTDATA(jj,4) = SVA; % Annual variation, deg C
OUTDATA(jj,5) = SVD; % Mean diurnal variation, deg C
OUTDATA(jj,6) = EHTCS;% EHT on surface
OUTDATA(jj,7) = rim; % uncorrected rim mean, microns
OUTDATA(jj,8) = sig; % Uncorrected rim sd, microns
OUTDATA(jj,9) = z; % artifact burial depth, m
OUTDATA(jj,10)= NS; % sample size
OUTDATA(jj,11)= FL; % Obsidian flow
OUTDATA(jj,12)= rimprimeA; %EHT corrected rim mean
OUTDATA(jj,13)= SDprime; % Rim SD, corrected for EHT
OUTDATA(jj,14)= t1S; % Age for surface conditions
OUTDATA(jj,15)= t1D; % Age at depth
OUTDATA(jj,16)= t1A; % Age for artifact buried YB fraction
OUTDATA(jj,17)= MODSD; % Source/process SD of age, yrs +/-
OUTDATA(jj,18)= MODSD/sqrt(NS) ; % Probable error of the mean
OUTDATA(jj,19)= t1N*sqrt(Labvar); % Age variance due to rim reading
OUTDATA(jj,20)= t1N*sqrt(EHTvar); % Age variance due to EHT uncertainty
OUTDATA(jj,21)= t1N*sqrt(Watervar); % Age variance due to intrinsic
water variations
OUTDATA(jj,22)= t1N*sqrt(Ratevar); % Age variance due to ascribed rate
OUTDATA(jj,23)= sqrt(SFvar); % Age variance due to site formation
processes
OUTDATA(jj,24)= NOM; % Nominal condition flag value
end
```

```
dlmwrite('LBOut.csv', OUTDATA, ',')
fprintf('Run Complete')
```