PLAGIOCLASE COMPOSITIONS OF EUCRITES AND EUCRITE-TYPE ACHONDRITES. D. W. Mittlefehldt[1], [1]Astromaterials Research Office, NASA-Johnson Space Center, Houston, TX, USA (david.w.mittlefehldt@nasa.gov).

Introduction: Eucrites are basalts, diabases and gabbros composed of ferroan pigeonite and augite, calcic plagioclase, and a silica phase, with accessory amounts of ilmenite, chromite, Ca-phosphate, troilite, metal and olivine [1]. Many of the gabbroic-textured eucrites are cumulates from a mafic magma, while most other eucrites are close to melt compositions [2]. These are referred to as cumulate and basaltic eucrites. Petrologic, compositional and isotopic studies have identified several mafic achondrites with eucritic mineralogy that have anomalous properties, and some of these are considered to have been derived from different parent asteroids than normal eucrites (e.g., [3-6]). These are referred to as eucrite-type achondrites, and they include cumulate and basaltic types.

Petrologic studies of eucrites often concentrate on pyroxene compositions to reveal the petrogenetic history of the rocks and plagioclase compositions are less utilized [6-8]. Here I examine Na and K variations of a suite of basaltic and cumulate eucrites and eucrite-type achondrites.

Samples and Methods: A total of 34 meteorites have been studied, including 19 basaltic eucrites, 5 Stannern-group basaltic eucrites, 4 cumulate eucrites, 4 eucrite-type basalts, and 2 eucrite-type cumulates. Included in this total are data on eucrite-type basalt Emmaville analyzed at JSC [9]. Samples were analyzed on three generations of electron microprobes at JSC over the course of three decades. Early analyses were done using a 15 kV, 20 nA, focused beam which was determined to be safe for the typically calcic plagioclases of eucrites. Later, the more sodic compositions were found to suffer Na mobilization under these conditions. Subsequent analyses were done using either a 3 or 5 µm defocused beam, which were proven safe for the most sodic plagioclases encountered.

Results: The Na-K relationships are shown using plots of Or vs. Ab end-members (Fig. 1) and K/Na vs. An (Fig. 2). GRA 98098 shows the widest range of Ab contents of the suite and has smoothly varying Or contents with Ab (Fig. 1a). A two-degree polynomial fit to the GRA 98098 data is used as a basis of comparison for other meteorites (Fig. 1). Key features are: (i) except for eucrite-type cumulate EET 92023, cumulates have narrow ranges of Ab and Or compared to basalts; (ii) highly metamorphosed basalts (BTN 00300, Ibitira) have narrow ranges of Ab and Or like those of cumulates; (iii) the most calcic plagioclases of basaltic eucrites overlap those of cumulate eucrites; (iv) the most calcic plagioclases in Stannern-group eucrites are distinctly more sodic; (v) K-rich compositions (above the GRA 98098 polynomial) are present in all petrologic types, but are most common in Stannern-group eucrites; and (vi) significant variations in initial K/Na are observed for eucrites and eucrite-type achondrites.

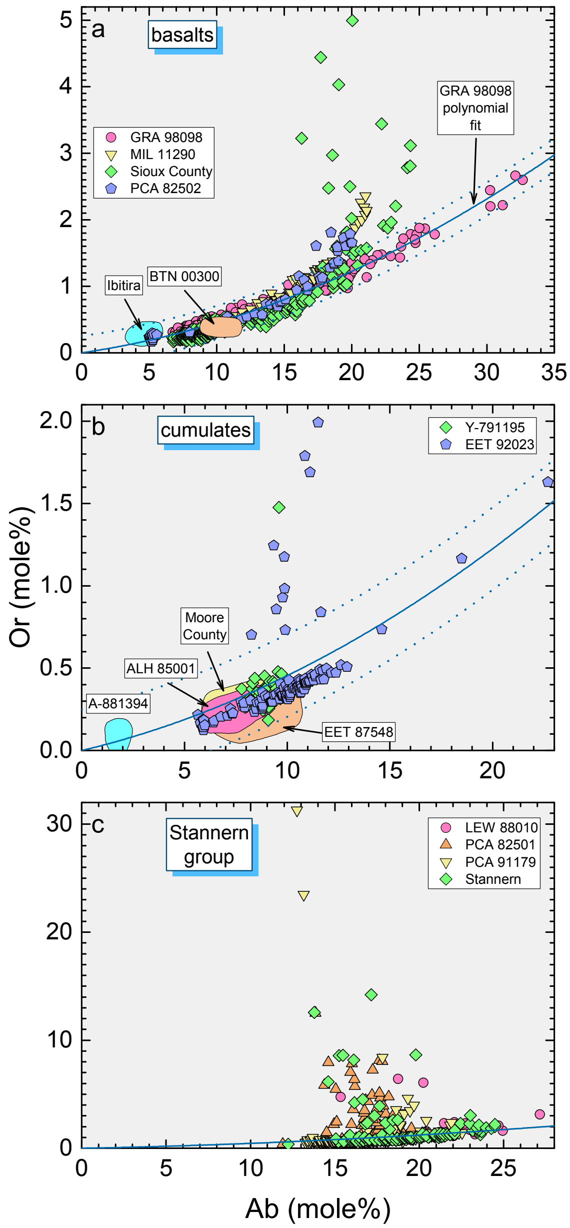

Figure 1. Or vs. Ab plots for select eucrites and eucrite-type achondrites. Note differences in scales.

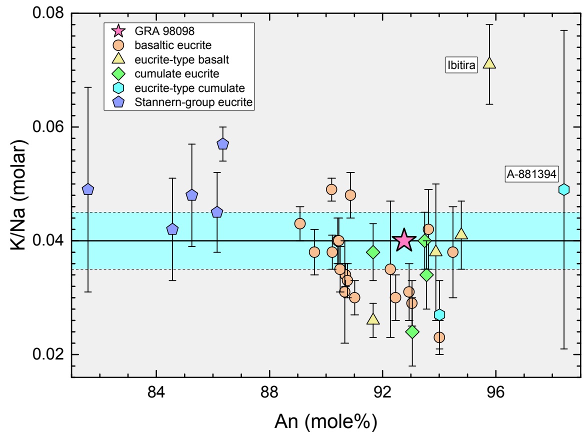

Figure 2. K/Na vs. An for the average of the five most calcic analyses from each meteorite. Horizontal band is the average and standard deviation for GRA 98098.

Discussion: The most calcic plagioclases in basaltic eucrites overlap the range for cumulate eucrites (Fig. 2), suggesting that plagioclases more faithfully record initial magmatic compositions than do pyroxenes. This is understandable because of the slower diffusion rates in plagioclase due to the necessity for coupled CaAl-NaSi diffusion (e.g., [10]).

The substantially less calcic compositions for Stannern-group eucrites (Fig. 2) could indicate that their parent magmas had a generally higher albite component than did main-group eucrites. This might be consistent with the melt-hybridization model for formation of Stannern-group eucrites [11]. In this model, melts of main-group eucrite composition (melt 0) interact with earlier-formed basalts, which are partially melted. The crustal melts are mixed with melt 0 to form a hybrid composition containing enhanced incompatible trace element contents, but major element contents only modestly changed. Melting of the earlier-formed crust would include melting of plagioclase, with the most sodic compositions preferentially being melted.

The process hypothesized for generation of Stannern-group eucrites [11] is an assimilation-fractional-crystallization (AFC) process. An important component of the heat needed to assimilate the country rock is provided by latent heat of crystallization of the intruding magma [12]. Thus, in the case of Stannern-group eucrite formation, melt 0 would be crystallizing pyroxene and plagioclase. This ought to result in the most calcic plagioclase compositions being like those in main-group eucrites, contrary to observations. This might suggest that the assimilation process includes exchange between melt 0 and the country rock, rather than strictly being due to partial melting.

Many of the eucrites and eucrite-type achondrites have plagioclases with K "hot spots" (Fig. 1). Potassium "hot spots" are uncommon in cumulate eucrites and highly metamorphosed basaltic eucrites, but occur in about half of the basaltic eucrites. All Stannern-group eucrite plagioclase contain abundant K "hot spots" (Fig. 1c), and in this they are distinct from other basaltic eucrites. The highest Or content found in a basaltic eucrite is $Or_{\sim 19}$ for MIL 05041, and in a Stannern-group eucrite is $Or_{\sim 33}$ from PCA 91179. These analyses likely reflect partial beam overlap on potassium feldspar grains; <10 μm grains are present in several eucrites [13]. Potassium feldspar is more abundant in PCA 91179 than in basaltic eucrites [13].

There are significant variations in K/Na for the most calcic plagioclases within the suite (Fig.2). Plagioclase was the first Na and K bearing phase to crystallize from eucritic magmas, and the differences in K/Na plausibly reflect variations in magma composition. Some of this variation might be caused by fractionation of the eucrite suite during crystallization; the basaltic eucrites with the highest K/Na tend to have more sodic compositions. However, there are also real differences in K/Na for plagioclases with similar An contents (Fig. 2).

Key Findings: Plagioclase compositions potentially record properties of the parent magmas that have been lost from pyroxenes because of more rapid diffusion in the latter. Significant observations are: (i) the most calcic plagioclases in Stannern-group eucrites are more sodic than those in basaltic eucrites; (ii) K "hot spots" are quite common, especially in basalts, considering how rarely K-feldspar is reported; (iii) variations in K/Na in initial plagioclases reflect variations in primary magmas in some cases.

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