INDEX OF

SLIDES OF GEOLOGIC MAP, MINERAL OCCURRENCE MAPS, GEOCHEMICAL MAPS, HEAVY MINERAL MAPS, AND MINERAL RESOURCE POTENTIAL MAPS, CHARLOTTE 1° x 2° QUADRANGLE, NORTH CAROLINA AND SOUTH CAROLINA

(CUSMAP PROGRAM)

Compiled by

J. E. Gair

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[Authors of individual maps on slides are listed after titles of slides]

A mineral-resource appraisal of the Charlotte 1° x 2° quadrangle, North Carolina and South Carolina, has been done between 1978 and 1982 under the Conterminous United States Mineral Resource Appraisal Program (CUSMAP). The mineral-resource appraisal is based principally on the evaluation of geology, geophysics, past and present mines (mineral occurrences), and heavy mineral occurrences in pan concentrates of stream sediments. Mineral production data also provide additional information bearing on the potential for as-yet undiscovered mineral occurrences. Maps and a comprehensive report on the geology and mineral resource potential are being prepared for publication. A public meeting was held in Charlotte, N.C., in September, 1982, at which the results of the CUSMAP study and some of the major topics of the intended publication were presented orally. At the meeting, preliminary versions of the maps and three already-published geophysical maps were displayed or were shown as slides in support of the oral presentations. Wide interest, particularly in the maps, has prompted this open-file release of the maps in the form of slides to make available to the public at the earliest possible date the map information shown at the Charlotte meeting.

The Charlotte 1° x 2° quadrangle extends from the Blue Ridge province on the northwest across a nearly complete section of the Piedmont to a basin of Triassic sedimentary rocks on the southeast only a few miles from the Coastal Plain. Piedmont belts spanned between the Blue Ridge and the Triassic rocks are the Inner Piedmont, Kings Mountain, Charlotte, and Carolina Slate belts. The rocks northwest of the Triassic basin are crystalline, metamorphosed mainly in the greenschist facies in the Carolina slate belt, and in the amphibolite facies farther to the northwest. The rocks of the quadrangle have been weathered to saprolite reaching depths of 200 feet (60 meters) in the Inner Piedmont.

The CUSMAP study of the Charlotte quadrangle has utilized a number of methods. A geologic map was prepared, combining new mapping with the results of previous studies. Preparation of the geologic map was greatly facilitated by aero-radiometric, aeromagnetic, and gravity geophysical surveys. The mineral resource appraisal was based on a review of mines and mineral prospects in the quadrangle and on an extensive geochemical-heavy mineral survey, in conjunction with the identification of favorable geologic zones. In this survey, some 2400 samples of pan concentrates were collected and further refined in the laboratory by bromoform separations and by the preparation of magnetically separated fractions. Splits of these fractions were analyzed spectrographically and most were examined by binocular microscope for their heavy-mineral content. Data from the geologic map, from mining and prospecting, and from the geochemical-heavy mineral survey have been used to prepare mineral resource potential maps. The slides of this open-file report include one of a hand-colored version of the geologic map, slides showing mineral occurrences (mines and prospects, mainly) computer-printed from data entered in the Computerized Resource Information Bank (CRIB), geochemical data, heavy mineral data and combined geochemical and heavy mineral data, and mineral resource potential maps for many of the known commodities and for a few potential commodities. The geophysical maps have already been published (Daniels and Zietz, 1981, 1982; Wilson and Daniels, 1980), and a "simplified geologic map" of the quadrangle has previously been open filed (Goldsmith and others, 1981).

In making the geochemical survey, samples were taken within a few miles of the heads of major streams and of the tributaries of these streams. By keeping the size of the drainage basin small, the variety of rocks that contribute detritus to a sample is usually reduced, thus facilitating a correlation between sample composition and the geology of the drainage basin. Despite uniform sampling procedures, samples are nevertheless quite varied. For instance, at some sites in the mountainous area in the northwestern part of the quadrangle, many clasts in the stream sediment are several yards in diameter and the collection of fine detritus suitable for a sample required a 1/2-hour search, whereas not far to the east, finer-grained sediment was abundant. With the exclusion of boulders, cobbles, and coarse pebbles, each sample consisted of about 10 lbs of clay to granule- or fine gravel-size material. The heavy minerals were extracted from this material at the sample site with a gold pan. The concentrates were sieved at 20 mesh. Some samples collected in the same manner during previous surveys of the area were also used in the geochemical survey. The pan concentrate samples were further cleaned in the laboratory with bromoform (sp. gr. 2.89). The resulting heavy mineral concentrates were each separated magnetically into four fractions: a hand magnet fraction and magnetic separator fractions, magnetic and non-magnetic at a 1 amp. setting and magnetic at a 0.5 amp. setting of the magnetic separator. Additional details of procedures will be published with a series of U.S. Geological Survey MF maps being prepared for individual geochemical elements (many of the slides of this open-file report are similar to the MF maps that will be published). Most common ore minerals occur principally in the non-magnetic fraction. The non-magnetic fraction also contains most of the zircon, sillimanite, kyanite, spinel, apatite, sphene, and TiO_2 minerals, and so is generally the most useful fraction. The magnetic fraction at 1 amp. is largely of monazite in the Inner Piedmont. It was necessary to remove monazite from concentrates before analysis because of the high content of (radiogenic) lead in the monazite, and because the cerium of monazite interfered with the spectrographic analysis of other elements. East of the Inner Piedmont, the magnetic concentrates at 1 amp. contain very abundant epidote, clinozoisite, ilmenite partly converted to leucoxene, staurolite, and locally, spinel. The magnetic fraction separated at 0.5 amp. contains abundant garnet in the Inner Piedmont, dark ferromagnesian minerals in the Charlotte belt, and ilmenite in most provinces. The mineral proportions of each fraction were estimated, using a binocular microscope.

Each sample was analyzed semiquantitatively for 31 elements using a six-step, D.C. arc, optical-emission spectrographic method (Grimes and Marranzino, 1968). The semiquantitative spectrographic values are reported as one of six steps per order of magnitude (1, 0.7, 0.5, 0.3, 0.2, 0.15) and as multiples of 10 of these numbers in parts per million (ppm); the ppm values are the approximate geometric midpoints of the concentration ranges, precise to within one adjoining interval for 83 percent of the measurements, and within two adjoining intervals for 96 percent of the measurements (Motooka and Grimes, 1976).

Most of the geochemical-heavy mineral samples were collected by J. W. Whitlow and W. R. Griffitts. Mineral analyses were made by W. R. Griffitts, K. A. Duttweiler, J. W. Whitlow, and C. L. Bigelow, with special mineral determinations by Theodore Botinelly. All spectrographic analyses were made by D. F. Siems. Steve McDanal and Christine McDougal entered spectrographic data in the U.S. Geological Survey RASS file. Many of the geochemical maps were computer-printed by H. V. Alminas, L. O. Wilch, J. D. Hoffman, and T. L. Mareau. Heavy mineral distribution maps were plotted by K. A. Duttweiler.

All analytical data for sample material other than concentrates shown in the map-slides are taken from reports by Heffner and Ferguson (1978) and Ferguson (1979). Such sample material is minus 100-mesh sediment collected during the National Uranium Resource Evaluation (NURE) program of the U.S. Department of Energy.

The slides included in this open-file report are grouped under the following headings: Geology and Explanation (A1-A11), Mineral Occurrence Maps, Computer-Printed from CRIB (B-I), Geochemical Sampling Program--Map of Sample Locations (J), Maps of Grouped Geochemical Data--Small-Scale Tektronix Maps (K-AA), Geochemical Summary Maps--Originals at Full Size and 1:250,000 Scale (BB-SS), Heavy Mineral Maps and Maps of Other Materials in Pan Concentrates (TT-YY), and Mineral Resource Potential Maps (ZZ-MMM).

Slides, of course, are not as satisfactory a medium for the presentation of map data as the maps themselves, but can be a useful substitute. Many of the geochemical map-slides are available in pairs, with data points visible on a clear base, and shown less distinctly on a topographic base.

The slides of "grouped geochemical data" are those shown during the talk on geochemistry during the first day of the meeting, whereas the slides of "geochemical summary maps" are mainly those displayed at the poster session on the second day of the Charlotte meeting. The slides of "grouped geochemical data" have been made from small computer-printed (Tektronix) maps (clear base) which represent the Charlotte quadrangle in a somewhat different ratio of north-south to east-west map boundaries than the true ratio of those boundaries on the full-size, 1:250,000 scale map of the quadrangle. The height (north-south) to width (east-west) ratio of the full-size map is about 0.61, whereas the ratio of the same boundaries on the small Tektronix maps is about 0.69. Therefore, in attempting to overlay data from slides of the small maps onto full-size maps, corrections in the locations of data points will be necessary.

A cautionary note: Most of the geochemical maps were computer-printed, so the slides made from them are of varying legibility; information may have to be obtained from some slides by use of a hand lens.

List of Slides

[All data from USGS CUSMAP program, except that from NURE program, where indicated]

<u>OF 82-1074-A to MMM</u> (all slides)

<u>A1 - A11. Geologic map and explanation</u>

A1 Geologic map. By Richard Goldsmith, Daniel J. Milton, and J. Wright Horton, Jr.

A2 Explanation for geologic map (Item A1).

A2 Correlation of geologic units on geologic map (Item A1).

A3 Explanation for geologic map (Item A1).
Sedimentary and volcanic rocks and their metamorphosed equivalents.

A4 Explanation for geologic map. Continuation of sedimentary and volcanic rocks and their metamorphosed equivalents.

A5 Explanation for geologic map. Continuation of sedimentary and volcanic rocks and their metamorphosed equivalents.

A6 Explanation for geologic map. Continuation of sedimentary and volcanic rocks and their metamorphosed equivalents.

A7 Explanation for geologic map. Intrusive and altered rocks.

A8 Explanation for geologic map. Continuation of intrusive and altered rocks.

A9 Explanation for geologic map. Continuation of intrusive and altered rocks.

A10 Explanation for geologic map. Continuation of intrusive and altered rocks. Footnotes about geologic names.

A11 Explanation for geologic map. Structure symbols. References.

B - I. Mineral occurrence maps

B Occurrence of construction materials. By J. P. D'Agostino and W. D. Rowe, Jr. (Computer-printed from CRIB 1/)

C Occurrence of kyanite, sillimanite, lithium, mica, and feldspar. By J. P. D'Agostino and W. D. Rowe, Jr. (Computer-printed from CRIB 1/)

D Occurrence of gold. By J. P. D'Agostino and W. D. Rowe, Jr. (Computer-printed from CRIB 1/)

E Occurrence of copper, lead, and zinc. By J. P. D'Agostino and W. D. Rowe, Jr. (Computer-printed from CRIB 1/)

F Occurrence of thorium, tin, and niobium. By J. P. D'Agostino and W. D. Rowe, Jr. (Computer-printed from CRIB 1/)

G Occurrence of quartz, barite, and fluorite. By J. P. D'Agostino and W. D. Rowe, Jr. (Computer-printed from CRIB 1/)

H Occurrence of iron. By J. P. D'Agostino and W. D. Rowe, Jr. (Computer-printed from CRIB 1/)

I Occurrence of gemstones. By J. P. D'Agostino and W. D. Rowe, Jr. (Computer-printed from CRIB 1/)

J. Geochemical sampling program

J Map showing all sample locations.

1/ Acronym for Computerized Resource Information Bank

K-AA Tektronix (small-scale) maps of grouped geochemical data. Clear base

K Copper, non-magnetic fraction. Areas also containing anomalous lead are outlined. Cu groupings in parts per million: 300, 500, 700-1000, 1500-5000. By W. R. Griffitts and D. F. Siems.

L Lead, non-magnetic fraction, Pb groupings in parts per million: 150-200, 300-700, 1000-2000, 3000-20,000. By W. R. Griffitts and D. F. Siems.

M Lead + insignificant thorium, non-magnetic fraction. Pb and Th groupings in parts per million: Pb equal to or more than 1000; Th equal to or less than 200. By W. R. Griffitts and D. F. Siems.

N Zinc, magnetic fraction at 1 amp. Zn groupings in parts per million: 3000-7000, 10,000-15,000. By W. R. Griffitts and D. F. Siems.

O Zinc, non-magnetic fraction + cadmium, copper, and lead. Data groupings shown only for zinc, in parts per million: 500-1500, 2000-3000, 5000-7000, 10,000-15,000. By W. R. Griffitts and D. F. Siems.

P Tin, non-magnetic fraction. Sn groupings in parts per million: 300-700, 1000-15,000, 2000-5000. By W. R. Griffitts and D. F. Siems.

Q Beryllium, non-magnetic fraction. Be groupings in parts per million: 20-70, 100-700, 1000. By W. R. Griffitts and D. F. Siems.

R Niobium, non-magnetic fraction. Nb groupings in parts per million: 200-500, 700-1000, 1500-10,000. By W. R. Griffitts and D. F. Siems.

S Niobium, magnetic fraction at 0.5 amp. Nb groupings in parts per million: 500-1000, 1500-5000. By W. R. Griffitts and D. F. Siems.

T Niobium + cobalt, magnetic fraction at 0.5 amp. Nb equal to or more than 200 parts per million; Co equal to or more than 200 parts per million. By W. R. Griffitts and D. F. Siems.

U Tungsten detected in non-magnetic fractions and in magnetic fractions at 0.5 amp. Limit of detection 100 parts per million. By W. R. Griffitts and D. F. Siems.

V Bismuth, non-magnetic fraction. Bi equal to or more than 100 parts per million. By W. R. Griffitts and D. F. Siems.

W Cobalt, non-magnetic fraction. Co groupings in parts per million: 50-70, and equal to or more than 100. By W. R. Griffitts and D. F. Siems.

X Cobalt and low magnesium, magnetic fraction at 0.5 amp. Cobalt equal to or more than 200 parts per million; Mg less than 0.5 percent. By W. R. Griffitts and D. F. Siems.

Y Cobalt and high manganese, magnetic fraction at 0.5 amp. Co equal to or more than 200 parts per million; Mn equal to or more than 10,000 parts per million. By W. R. Griffitts and D. F. Siems.

Z Thorium, non-magnetic fraction. Th groupings in parts per million: 200-500, 1000, 5000. By W. R. Griffitts and D. F. Siems.

AA Barium, non-magnetic fraction. Ba groupings in parts per million: 700-2000, 3000-7000, and equal to or more than 10,000. By W. R. Griffitts and D. F. Siems.

BB-SS Geochemical Summary Maps (1:250,000 scale). Clear and topographic bases

BB Base metals + cobalt; broad areas shown by patterns, anomalous for Pb + Cu, Zn + Pb + Cu, and Co, considered favorable for mineralization. Clear base. By W. R. Griffitts.

CC Tin-beryllium-niobium. Broad areas shown by pattern that are geochemically anomalous for Sn, Be, and Nb, and have potential for mineralization. Clear base. By W. R. Griffitts.

DD1 Copper in non-magnetic fraction. Cu groupings in parts per million: less than 10, 10-30, 50-100, more than 100. Clear base. Poor slide; copy may be faint.

DD2 DITTO. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

EE1 Lead in (1) non-magnetic fraction and (2) minus 100-mesh (NURE) sediment samples. Pb groupings in parts per million: (1) 20-30, 50-100, 150-700, 1000 or more; (2) less than 10, 10-14, 15-100. Clear base.

EE2 DITTO. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

FF Zinc, non-magnetic fraction. Zn groupings in parts per million: 500-1000, more than 1000. Clear base. By W. R. Griffitts J. W. Whitlow, and D. F. Siems.

GG1 Zinc in (1) non-magnetic fraction and (2) minus 100-mesh (NURE) sediment samples + spinel. Zn groupings in parts per million: (1) 500-1000, more than 1000; (2) less than 40, 40-59, 60-89, 90 or more. Spinel less than and more than 3 percent. Clear base.

GG2 DITTO. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

HH Zinc in magnetic fraction at 1 amp. Zinc groupings in parts per million: less than 500, 500-1000. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

II Cadmium in non-magnetic fraction, 50 parts per million or more. Clear base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems. Poor slide; copy may be faint.

JJ1 Molybdenum in (1) non-magnetic fraction and (2) minus 100-mesh (NURE) sediment samples. Mo groupings in parts per million: (1) 10-15, 20, 30, 50; (2) less than 5, 5-10, 10-15. Clear base.

JJ2 DITTO. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

KK1 Molybdenum in magnetic fraction at (1) 0.5 amp. and (2) 1 amp. Mo groupings in parts per million: (1) 10; (2) 10-15, 20, 30, 50. Clear base. Poor slide; copy may be faint.

KK2 DITTO. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

LL1 Tin in (1) non-magnetic fraction and (2) minus 100-mesh (NURE) sediment samples. Sn groupings in parts per million: (1) less than 20, 30-100, 150-300, 1500 or more; (2) 25-90, 100 or more. Clear base.

LL2 DITTO. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

MM1 Niobium in (1) magnetic fraction at 0.5 amp. and (2) minus 100-mesh (NURE) sediment samples. Nb groupings in parts per million: (1) 50, 70-150, 200-700, 1000; (2) 5-30, 35-250. Clear base.

MM2 DITTO. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

NN1 Tungsten in (1) non-magnetic fraction, (2) magnetic fraction at 0.5 amp., and (3) minus 100-mesh (NURE) sediment samples. W groupings in parts per million: (1) 100 or more; (2) 100 or more; (3) 2-9, 10-40. Clear base.

NN2 DITTO. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

OO1 Cobalt in non-magnetic fraction. Cobalt groupings in parts per million: 10-15, 20-30, 50-100, 150. Clear base. Poor slide; copy may be faint.

OO2 DITTO. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

PP1 Cobalt in magnetic fraction at 0.5 amp. Cobalt groupings in parts per million: less than 10, 10-50, 70-100, more than 150. Clear base.

PP2 DITTO. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

QQ Barium in (1) non-magnetic fraction and (2) minus 100-mesh (NURE) sediment samples. Ba groupings in parts per million: (1) 700-2000, 3000-7000, 10,000; (2) 400-700, more than 700. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

RR Beryllium in (1) non-magnetic fraction and (2) minus 100-mesh (NURE) sediment samples. Be groupings in parts per million: (1) less than 2, 2-10, 15-30, 50-100, more than 100; (2) less than 2, 2-4.5, 5-84. Topographic base. By W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

SS1 Lithium in minus 100-mesh (NURE) sediment samples. Li groupings in parts per million: 5-10, 11-20, 21-100, more than 100. Clear base. Poor slide; copy may be faint.

SS2 DITTO. Topographic base. By W. R. Griffitts.

TT-YY Heavy Mineral Maps; Maps of Other Materials in Pan Concentrates

TT1 Scheelite in non-magnetic concentrates. Scheelite groupings at less than and more than 2 percent. Clear base.

TT2 DITTO. Topographic base. By K. A. Duttweiler, W. R. Griffitts, and J. W. Whitlow.

UU Distribution of titanium minerals (ilmenite, rutile, anatase, and brookite); areas also shown in which minus 100-mesh sediments contain at least 1 percent Ti. Clear base. By K. A. Duttweiler, W. R. Griffitts, and J. W. Whitlow.

VV Spinel in non-magnetic concentrates. Spinel groupings at less than and more than 3 percent. Clear base. By K. A. Duttweiler, W. R. Griffitts, and J. W. Whitlow.

WW Staurolite in concentrates. Staurolite groupings at less than 10 percent and equal to or more than 10 percent. Clear base. By K. A. Duttweiler, W. R. Griffitts, and J. W. Whitlow.

XX Limonite in concentrates. Limonite concretions and areas of neutral soil. Topographic base. By K. A. Duttweiler, W. R. Griffitts, and J. W. Whitlow.

YY Metallic artifacts in concentrates. Locations of lead and copper artifacts. Topographic base. By K. A. Duttweiler, W. R. Griffitts, and J. W. Whitlow.

ZZ-MMM Mineral Resource Potential Maps. 1:250,000 scale. Most on clear base.

ZZ Copper Resources Potential, Charlotte 1° x 2° Quadrangle, N.C.-S.C. By J. E. Gair. Geochemistry by W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

AAA Lead Resources Potential, Charlotte 1° x 2° Quadrangle, N.C.-S.C. By J. E. Gair and W. R. Griffitts. Geochemistry by W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

BBB Zinc Resources Potential, Charlotte 1° x 2° Quadrangle, N.C.-S.C. By J. E. Gair and W. R. Griffitts. Geochemistry by W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

CCC Base-Metal Resources Potential, Charlotte 1° x 2° Quadrangle, N.C.-S.C. By J. E. Gair and W. R. Griffitts. Geochemistry by W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

DDD1 Gold Resources of the Charlotte 1° x 2° Quadrangle, N.C.-S.C. (showing only areas broadly favorable for gold resources). Clear base. By J. E. Gair.

DDD2 Gold Resources of the Charlotte 1° x 2° Quadrangle, N.C.-S.C. (showing types of data combined with areas broadly favorable for gold resources). Topographic base. By J. E. Gair. Data provided by W. R. Griffitts, J. P. D'Agostino, J. W. Whitlow, D. F. Siems, and K. A. Duttweiler.

DDD3 Gold Resources of the Charlotte 1° x 2° Quadrangle, N.C.-S.C. (showing areas of resource potential for the different gold models). Clear base. By J. E. Gair and J. P. D'Agostino. Data provided by W. R. Griffitts, J. P. D'Agostino, J. W. Whitlow, D. F. Siems, and K. A. Duttweiler.

EEE Tin Resource Potential, Charlotte 1° x 2° Quadrangle, N.C.-S.C. By J. E. Gair. Geochemistry by W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

FFF Resources Potential for Beryllium, Molybdenum, and Niobium in Charlotte 1° x 2° Quadrangle, N.C.-S.C. By J. E. Gair. Geochemistry by W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

GGG Resources Potential for Lithium, Kyanite-Sillimanite, and Barite, Charlotte 1° x 2° Quadrangle, N.C.-S.C. By J. W. Horton, Jr.

HHH Tungsten Resources Potential, Charlotte 1° x 2° Quadrangle, N.C.-S.C. By J. E. Gair. Geochemistry by W. R. Griffitts, J. W. Whitlow, and D. F. Siems.

III Resources Potential for Thorium (Monazite), Charlotte 1° x 2° Quadrangle, N.C.-S.C. By J. E. Gair. Geochemical data from NURE; Data on monazite distribution from D'Agostino and Rowe, this series (OF 82-1074-F).

JJJ Uranium Resources Potential, Charlotte 1° x 2° Quadrangle, N.C.-S.C. Based on data from surveys other than CUSMAP; compiled by J. E. Gair.

KKK Potential for Crushed Stone Resources, Charlotte 1° x 2° Quadrangle, N.C.-S.C. By Richard Goldsmith, J. W. Horton, Jr., and D. J. Milton.

LLL Sand and Gravel Resources Potential, Charlotte 1° x 2° Quadrangle, N.C.-S.C. By J. P. D'Agostino and J. E. Gair.

MMM Clay Resources Potential, Charlotte 1° x 2° Quadrangle, N.C.-S.C. By J. E. Gair and J. P. D'Agostino. Based in part on published reports and on some data from Patricia Loferski, U.S. Geol. Survey.

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