GSA Data Repository Item # 8624

Title of article Brachiopods as Indicators of Original Isotopic Compositions in Some Paleozoic Limestones

Author(s) Brian N. Popp, Thomas F. Anderson, Philip A. Sandberg

see Bulletin v. 97, p. 1262 - 1269

Contents 34 pages

Appendix A - Explanation of Sample Numbering Scheme

APPENDIX

BRACHIOPODS AS INDICATORS OF ORIGINAL ISOTOPIC COMPOSITIONS IN SOME PALEOZOIC LIMESTONES

Brian N. Popp, Thomas F. Anderson, and Philip A. Sandberg

APPENDIX A

EXPLANATION OF SAMPLE NUMBERING SCHEME

Each specimen has been given an identification number which contains information about collection location, and if applicable, identity, luminescent character, and which portion of the specimen the sample came from. The number serves to reference specific locality, luminescence, taxonomic, and analytical data for samples. The following examples are to aid in deciphering the sample numbering scheme.

A1-1-WB

A1 - Refers to the country in which the sample was collected (see Appendix 3).
1 - Always the sample number, consecutive for each country.
WB - Portion of the shell sampled:
- NL - nonluminescent portion of brachiopod.
- SL - slightly luminescent portion of brachiopod.
- BL - brightly luminescent portion of brachiopod.
- WB - whole brachiopod sample (see text).
- M - associated matrix.
- IC - internal cement.

GB-79-5-NL-1

5 - Indicates that more than one individual of the same taxon was sampled.

B-14A-NL-2

14A - Indicated more than one slice was taken through the shell and sampled (e.g., 14C would indicate the third slice taken).
2 - Indicates more than one sample taken from that slice.

APPENDIX B

LUMINOSCOPE OPERATING CONDITIONS AND KEY TO CLASSIFICATION OF LUMINESCENCE CHARACTER

All CL observations were performed under the following conditions (cf. Marshall, 1978).

Equipment:

- Nuclide Corporation Luminoscope Model ELM-2A
- Recessed leaded glass and normal windows
- Zeiss Binocular Petrographic Microscope
- Objective lens: Zeiss UD series
- Standard petrographic thin sections polished to a mirror finish with 0.05 µm Gamma Alumina

Operating conditions:

- Accelerating voltage 10-14 KV
- Beam current 0.2-0.4 mA
- Beam focus: Macrophotography 1-2 cm (maximum, defocused), Microphotography 2-5 mm diameter (minimum)
- Gas in chamber: partially evacuated air

Photography:

- Macrophotography
  - Camera: Olympus OM-1 Single lens reflex 35 mm
  - Lens: Vivatar 55 mm Macro Zoom
  - Photographic film: Kodak Panatomic X (125 ASA)
  - Exposure time: 1-5 seconds
  - Processing: Kodak Dektol D-19, 5-6 minutes
- Microphotography
  - Camera: Olympus OM-1 Single lens reflex 35 mm
  - Lens: Zeiss 12X photo-occular
  - Photographic film: Kodak Panatomic X (125 ASA)
  - Exposure time: 15-120 seconds
  - Processing: Kodak Dektol D-19, 5-6 minutes

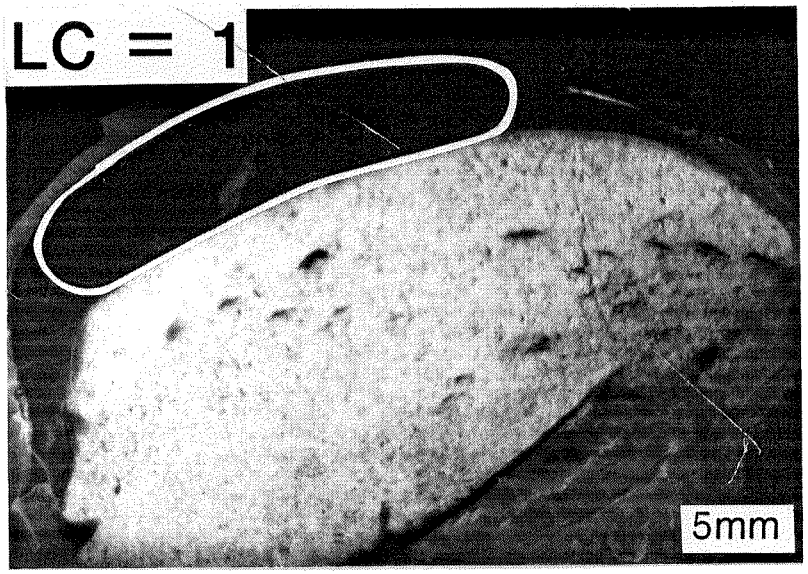
Cathodoluminescence characterization:

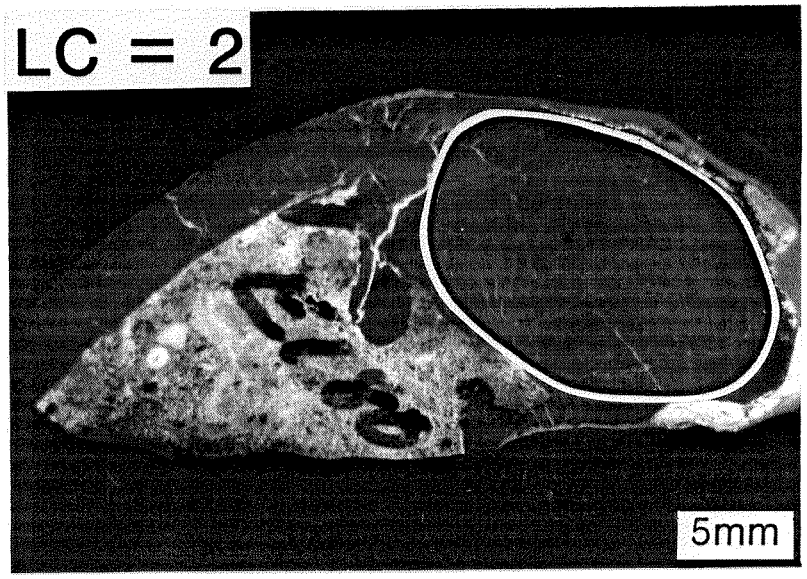
Figure A-1 illustrates the four qualitative categories of luminescence used in this study. Note that the characterization is based on the proportion of the shell that is luminescent and to a lesser extent the intensity. Each value assigned to a brachiopod is the result of at least two observations (i.e., before and after drilling).

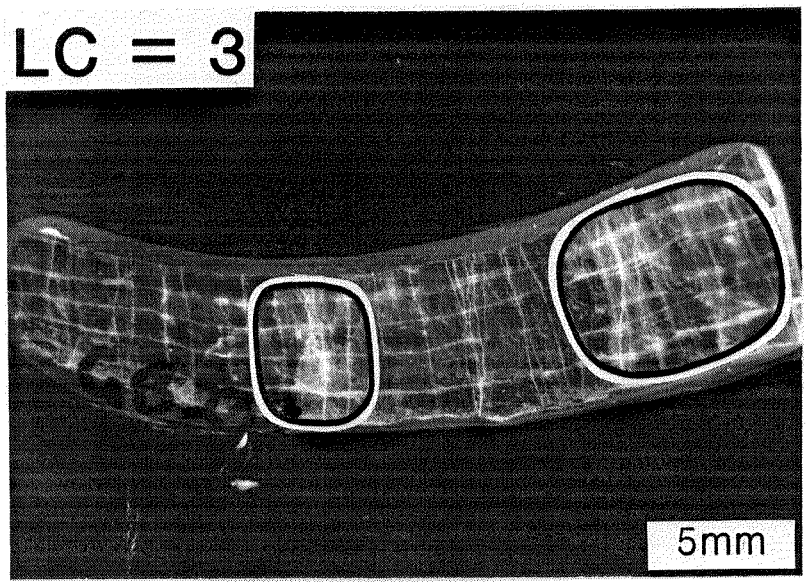
Marshall, D. J., 1978, Suggested standards for the reporting of cathodoluminescence results: Journal of Sedimentary Petrology, v. 48, p. 651-653.

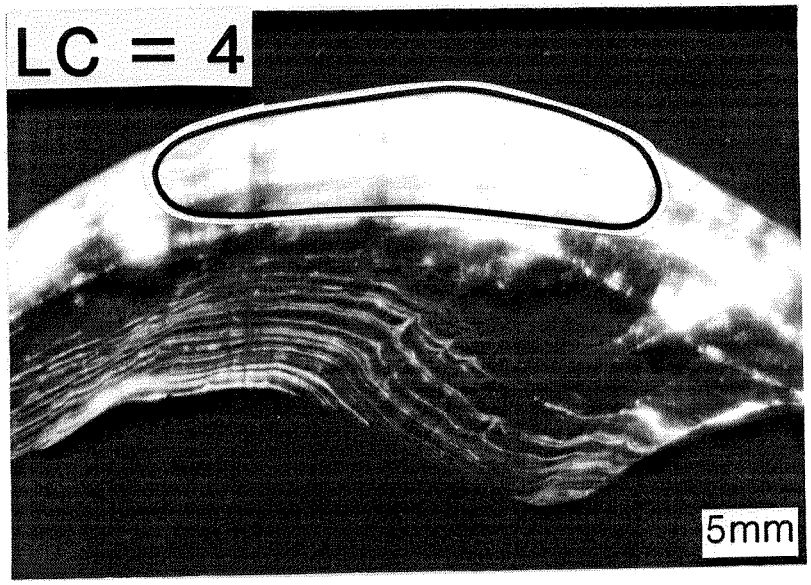
Figure A-B-1. Macrophotographs of the four "type" brachiopods selected for CL comparisons.

Luminescence Characteristics (LC) in Brachiopods









APPENDIX C

SAMPLE DESCRIPTION, LOCALITY, AND TAXONOMIC INFORMATION

Afghanistan

Af-1-1-SL-1	*Neospirifer* cf. *mucouri* (Waagen); B-1 508F Kajab (1:100000) E=394.6 N=3798.9; Early Permian (Sakmarian-Artinskian); Slightly luminescent, many cracks, heterogeneous.
Af-1-2-SL-1	*Neospirifer* cf. *mucouri* (Waagen); B-1 508F Kajab (1:100000) E=394.6 N=3798.9; Early Permian (Sakmarian-Artinskian); Slightly luminescent occurring as thin lines, penetrated brightly luminescent zone.
Af-6-SL-1	*Leptagonia* sp.; 514 BII Okafe (1:50000) E=402.4 N=3748.4; Early Carboniferous (Tournaisian); Luminescent lines parallel to growth lines with several cross-cutting, much Fe-rich calcite in matrix.
Af-7-SL-1	*Rhipidomella* sp.; 514 BII Okafe (1:50000) E=402.4 N=3748.4; Early Carboniferous (Tournaisian); Slight luminescence occurring randomly in shell, Fe-rich calcite in matrix.
Af-8-NL-1	*Syringothyris afghanica* (Plodowski); 514 BII Okafe (1:50000) E=402.4 N=3748.4; Early Carboniferous (Tournaisian); Nonluminescent except for few slightly luminescent lines which were penetrated during drilling.
Af-9-NL-1	*Unispirifer mucronatus* (Waterhouse); 514 BII Okafe (1:50000) E=402.4 N=3748.4; Early Carboniferous (Tournaisian); Penetrated several luminescent and Fe-rich cracks, Fe-rich calcite in matrix.
Af-10-NL-1	*Cyrtella* sp.; B-1 508F Kajab (1:100000) E=394.6 N=3798.9; Early Permian (Sakmarian-Artinskian); Nonluminescent except for a few thin luminescent and Fe-rich cracks penetrated during drilling, Fe-rich calcite in matrix.
Af-12-SL-1	Spirifer; Early Carboniferous; Dull luminescence throughout shell, brightly luminescent portion penetrated during drilling.
Af-27-NL-1	*Choristites* sp.; Senckenbergisches Museum sample #HAa; Early Permian (Sakmarian-Artinskian); Nonluminescent with some dark inclusions and Fe-rich calcite (mostly avoided)

Algeria

Al-1	*Gigantoproductus* sp.; El Ahmaa section, Adrar sheet, E=27.35 N=0.32, Western Sahara; Early Carboniferous (Early Serpukhovian).
Al-1-NL-1	Nonluminescent along thin growth band (1 mm), inner shell.
Al-1-NL-2	Nonluminescent along thin growth band (1.5 mm), midshell.
Al-1-NL-3	Nonluminescent along thin growth band (1.5 mm), some slight luminescence, midshell.
Al-1-NL-4	Nonluminescent along thin growth band (2 mm), some slight luminescence, midshell.
Al-1-NL-5	Nonluminescent along thin growth band (2 mm), outermost shell.

A1-1-NL-6	Nonluminescent along thin growth band (1 mm), outermost shell.
A1-1-NL-7	Nonluminescent along thin growth band (1 mm), midshell.
A1-1-NL-8	Nonluminescent along thin growth band (1 mm), outer shell.
A1-1-NL-9	Nonluminescent along thin growth band (1 mm), outermost shell.
A1-1-WB	Whole brachiopod.
A1-2	*Gigantoproductus* sp.; El Ahmaa section, Adrar sheet, E=27.35 N=0.32, Western Sahara; Early Carboniferous (Early Serpukhovian).
A1-2-NL-1	Nonluminescent, except drilled into brightly luminescent zone.
A1-2-WB	Whole brachiopod.
A1-3	*Gigantoproductus* sp.; El Ahmaa section, Adrar sheet, E=27.35 N=0.32, Western Sahara; Early Carboniferous (Early Serpukhovian).
A1-3A-NL-1	Nonluminescent with very few lightly luminescent lines.
A1-3B-NL-1	Nonluminescent.
A1-3B-NL-2	Nonluminescent.
A1-3-WB	Whole brachiopod.
A1-4	*Gigantoproductus* sp.; El Ahmaa section, Adrar sheet, E=27.35 N=0.32, Western Sahara; Early Carboniferous (Early Serpukhovian).
A1-4-NL-1	Nonluminescent with a few faintly luminescent lines parallel to growth banding.
A1-4-WB	Whole brachiopod.
A1-5	*Gigantoproductus* sp.; El Ahmaa section, Adrar sheet, E=27.35 N=0.32, Western Sahara; Early Carboniferous (Early Serpukhovian).
A1-5A-NL-1	Nonluminescent inner portion of shell, a slightly luminescent portion included.
A1-5A-SL-2	Variable luminescent as luminescent lines parallel to growth banding.
A1-5A-BL-3	Brightly luminescent zone covering outer 1/3 of shell.
A1-5B-BL-1	Brightly luminescent; TEST - next three samples are sequential from outer shell inward.
A1-5B-BL-2	Brightly luminescent; TEST sample 2.
A1-5B-BL-3	Brightly luminescent; TEST sample 3.
A1-5B-NL-4	Nonluminescent; TEST - next four samples are along growth bands, Band 1.
A1-5B-NL-5	Nonluminescent; Band 2.
A1-5B-NL-6	Nonluminescent; Band 3.
A1-5B-NL-7	Nonluminescent; Band 4 (lateral to Band 2).
A1-5B-BL-8	Brightly luminescent from near outer edge of shell.
A1-5B-BL-9	Brightly luminescent from near outer edge of shell.
A1-5-WB	Whole brachiopod.
A1-6	*Syringothyris jourdyi jourdyi*; Taouerta (near Bichar) E=30.5 N=2.30, Western Sahara; Early Carboniferous (Early Serpukhovian).
A1-6-NL-1	Nonluminescent with several thin luminescent cracks.
A1-6-WB	Whole brachiopod.
A1-7-SL-1	*Syringothyris jourdyi jourdyi*; Taouerta (near Bichar) E=30.5 N=2.30, Western Sahara; Early Carboniferous (Early Serpukhovian); Slightly luminescent including many thin luminescent cracks parallel to growth banding.
A1-8	*Syringothyris jourdyi jourdyi*; Taouerta (near Bichar) E=30.5 N=2.30, Western Sahara; Early Carboniferous (Early Serpukhovian).

A1-8-NL-1	Nonluminescent with a few slightly luminescent cracks included.
A1-8-WB	Whole brachiopod.
A1-9-NL-1	*Syringothyris jourdyi jourdyi*; Taouerta (near Bichar) E=30.5 N=2.30, Western Sahara; Early Carboniferous (Early Serpukhovian); Slightly luminescent including several thin luminescent lines.
A1-11-NL-1	*Syringothyris jourdyi jourdyi*; Taouerta (near Bichar) E=30.5 N=2.30, Western Sahara; Early Carboniferous (Early Serpukhovian); Slightly luminescent including some dull luminescence and several thin luminescent lines.
A1-12-SL-1	*Syringothyris jourdyi jourdyi*; Taouerta (near Bichar) E=30.5 N=2.30, Western Sahara; Early Carboniferous (Early Serpukhovian); Slightly luminescent including several thin luminescent lines.
A1-13	*Syringothyris jourdyi jourdyi*; Taouerta (near Bichar) E=30.5 N=2.30, Western Sahara; Early Carboniferous (Early Serpukhovian).
A1-13-SL-1	Slightly luminescent including several thin luminescent lines parallel to growth banding.
A1-13-SL-2	Slightly luminescent including several thin luminescent lines parallel to growth banding.
A1-13-WB	Whole brachiopod.

Austria

A-66-WB	*Gigantoproductus gigantus*; Bliberg-Kreuth; Early Carboniferous (Late Visean); Whole brachiopod.
A-68-WB	*Gigantoproductus gigantus*; Bliberg-Kreuth; Early Carboniferous (Late Visean); Whole brachiopod.
A-69-WB	*Gigantoproductus gigantus*; Bliberg-Kreuth; Early Carboniferous (Late Visean); Whole brachiopod.
A-70-WB	*Gigantoproductus gigantus*; Bliberg-Kreuth; Early Carboniferous (Late Visean); Whole brachiopod.

Belgium

B-1	*Gigantoproductus gigantus*; Hoyoux Valley, Royseux; Early Carboniferous (Late Visean; Asbian).
B-1A-NL-1	Nonluminescent with very few luminescent lines.
B-1B-NL-1	Two nonluminescent areas combined.
B-1B-NL-2	Nonluminescent.
B-1-WB	Whole Brachiopod.
B-11	*Gigantoproductus gigantus*; Hoyoux Valley, Royseux; Early Carboniferous (Late Visean; Asbian).
B-11-NL-1	Nonluminescent with a few luminescent lines.
B-11-WB	Whole Brachiopod.
B-14	*Gigantoproductus gigantus*; Hoyoux Valley, Royseux; Early Carboniferous (Late Visean; Asbian).
B-14A-NL-1	Nonluminescent.

B-14A-SL-1	Slightly luminescent along edge of shell.
B-14A-M	Black micritic matrix, dull luminescence.
B-14B-SL-1	Slight dull luminescence.
B-14B-NL-1	Nonluminescent.
B-14B-M	Black micritic matrix, dull luminescence.
B-14C-NL-1	Nonluminescent growth band.
B-14C-NL-2	Nonluminescent growth band.
B-14C-NL-3	Nonluminescent growth band, some thin luminescent lines.
B-14C-NL-4	Nonluminescent growth band, some thin luminescent lines.
B-14D-NL-1	Nonluminescent growth band, some thin luminescent lines.
B-14D-NL-2	Nonluminescent growth band, some thin luminescent lines.
B-14D-NL-3	Nonluminescent growth band.
B-14D-NL-4	Nonluminescent growth band.
B-14E-NL-1	Nonluminescent growth band.
B-14E-NL-2	Nonluminescent growth band, some thin luminescent lines.
B-14E-NL-3	Nonluminescent growth band.
B-14E-NL-4	Nonluminescent growth band, some thin luminescent lines.
B-14F-NL-1	Nonluminescent growth band.
B-14F-NL-2	Nonluminescent growth band.
B-14F-NL-3	Nonluminescent growth band.
B-14F-NL-4	Nonluminescent growth band.
B-14F-NL-5	Nonluminescent growth band.
B-14-WB	Whole Brachiopod.
B-15	*Gigantoproductus gigantus*; Hoyoux Valley, Royseux; Early Carboniferous (Late Visean; Asbian).
B-15A-NL-1	Nonluminescent containing a few slightly luminescent cracks.
B-15A-SL-2	Slight luminescence occurring parallel to growth banding.
B-15A-M	Black micritic matrix, dull luminescence.
B-15-WB	Whole brachiopod.
B-21	*Gigantoproductus gigantus*; Hoyoux Valley, Royseux; Early Carboniferous (Late Visean; Asbian).
B-21-SL-1	Slight luminescence occurring as dull luminescent lines.
B-21-WB	Whole brachiopod.
B-38-SL-1	*Daviesiella* sp.; "La Folie", Vise; Early Carboniferous (Early Visean; Chadian-Arundian).
B-41	*Daviesiella* sp.; "La Folie", Vise; Early Carboniferous (Early Visean; Chadian-Arundian).
B-41-SL-1	Slight luminescence occurring as thin luminescent lines and many Fe-rich nonluminescent cracks.
B-41-WB	Whole brachiopod.
B-67-WB	*Daviesiella* sp.; Railway cut west of Boineau; Early Carboniferous (Late Visean; Early Asbian); Whole brachiopod.
B-113-BL-1	*Linoproductus* sp.; Salet Quarry, Valley of the Molignee; Early Carboniferous (Early Visean; Arundian); Brightly luminescent.

Germany

DDR-1-SL-1	*Spirifer alatus*; Milbitz, near Gera, Zechstienkalk, Early Permian; Slightly luminescent with several luminescent cracks; silicified.

France

F-1-WB	*Gigantoproductus* sp.; Calearies d'Ardengost Limestone, French Pyr□nees, Montage d'Areng near Sierra de Costets, east of Arrean; Early Carboniferous (Early Serpukhovian), Whole brachiopod.
F-2	*Gigantoproductus* sp.; Calearies d'Ardengost Limestone, French Pyrenees, Montage d'Areng near Sierra de Costets, east of Arrean; Early Carboniferous (Early Serpukhovian).
F-2-SL-1	Nonluminescent with several dark Fe-rich cracks.
F-2-WB	Whole brachiopod.

Great Britain

GB-12-SL-1	*Gigantoproductus* sp.; Appletree Limestone (Middle Border Group) N 689 727; Early Carboniferous (Visean; Arundian-Holkerian); Slightly luminescent with luminescent lines occurring parallel to growth banding.
GB-30-WB	*Gigantoproductus* sp.; Redesdale Limestone, Quarry west of Hwy. A-68, NY 906 840; Early Carboniferous (Arundian-Holkerian); Whole brachiopod.
GB-33	*Gigantoproductus* sp.; Redesdale Limestone, Quarry west of Hwy. A-68, NY 906 840; Early Carboniferous (Arundian-Holkerian).
GB-33A-SL-1	Slight luminescence occurring parallel to growth banding, some Fe-rich calcite.
GB-33B-SL-1	Many luminescent cracks running through shell.
GB-33-WB	Whole brachiopod.
GB-35	*Gigantoproductus* sp.; Redesdale Limestone, Quarry west of Hwy. A-68, NY 906 840; Early Carboniferous (Visean; Arundian-Holkerian).
GB-35-SL-3	Some dull luminescent areas included.
GB-35-WB	Whole brachiopod.
GB-67	*Gigantoproductus* sp.; Cawdor Limestone, Once-a-week Quarry, one mile north of Sheldon SK 158 681; Early Carboniferous (Visean; Asbian-Brigantian).
GB-67A-NL-1	Nonluminescent except for several luminescent cracks parallel to growth banding.
GB-67B-SL-1	Nonluminescent area surrounded by luminescent material, included during drilling.
GB-67-WB	Whole brachiopod.
GB-75	*Gigantoproductus* sp.; Cawdor Limestone, Once-a-week Quarry, one mile north of Sheldon SK 158 681; Early Carboniferous (Visean; Asbian-Brigantian).
GB-75A-NL-1	Nonluminescent area surrounded by luminescent material, included during

	drilling.
GB-75B-SL-1	Slightly luminescent with brightly luminescent cracks included.
GB-75-WB	Whole brachiopod.
GB-79	*Martinia*sp.; Monsaldale Formation, Ashford Black Marble Quarry, Ashford SK 193 705; Early Carboniferous (Visean; Brigantian).
GB-79-1-NL-1	Nonluminescent with a few slightly luminescent cracks included.
GB-79-2-NL-1	Nonluminescent, some silicification.
GB-79-3-NL-1	Nonluminescent with several slightly luminescent cracks included.
GB-79-4-NL-1	Nonluminescent with several luminescent cracks included, some silicification.
GB-79-5-NL-1	Nonluminescent with a couple slightly luminescent cracks included, some silicification.
GB-79-6-NL-1	Nonluminescent.
GB-100-SL-1	*Daviesiella*sp.; Kneeshaw Lupton and Co., LTD. Llanddlus Quarry, Colown Bay, North Wales; Early Carboniferous (Visean; Asbian-Brigantian); Slightly luminescent with few luminescent and Fe-rich cracks included.
GB-102-SL-1	*Daviesiella*sp.; Kneeshaw Lupton and Co., LTD. Llanddlus Quarry, Colown Bay, North Wales; Early Carboniferous (Visean; Asbian-Brigantian); Slightly luminescent with few luminescent and Fe-rich cracks included.
GB-104-SL-1	*Daviesiella*sp.; Kneeshaw Lupton and Co., LTD. Llanddlus Quarry, Colown Bay, North Wales; Early Carboniferous (Visean; Asbian-Brigantian); Slightly luminescent with few luminescent and Fe-rich cracks included.
GB-173-SL-1	*Gigantoproductus*sp.; Arnside SD 446 781; Dalton Beds, Carboniferous Limestone, Early Carboniferous (Visean; Arundian); Several long luminescent lines parallel to growth banding.
GB-174	*Gigantoproductus*sp.; Arnside SD 446 781; Dalton Beds, Carboniferous Limestone, Early Carboniferous (Visean; Arundian).
GB-174A-SL-1	Dull luminescence throughout shell.
GB-174B-SL-1	Dull luminescence throughout shell and several luminescent cracks.
GB-174C-SL-1	Dull luminescence throughout shell and several luminescent cracks.
GB-175-SL-1	*Gigantoproductus*sp.; Arnside SD 446 781; Dalton Beds, Carboniferous Limestone, Early Carboniferous (Visean; Arundian); Shell has faint luminescent cracks parallel to growth banding.
GB-177-SL-1	*Gigantoproductus*sp.; Arnside SD 446 781; Dalton Beds, Carboniferous Limestone, Early Carboniferous (Visean; Arundian); Dull luminescence throughout shell.
GB-180-NL-1	Spirifer; Arnside SD 446 781; Dalton Beds, Carboniferous Limestone, Early Carboniferous (Visean; Arundian); Nonluminescent except for very few thin luminescent cracks parallel to growth banding.
GB-192	*Gigantoproductus*sp.; Pen-y-Ghent Stream cut SD 8545 7358; Hardlaw Limestone, Early Carboniferous (Visean; Brigantian).
GB-192-NL-1	Nonluminescent with a few Fe-rich and luminescent cracks.
GB-192-WB	Whole brachiopod.
GB-193	*Gigantoproductus*sp.; Pen-y-Ghent Stream cut SD 8545 7358; Hardlaw Limestone, Early Carboniferous (Visean; Brigantian).

GB-193-NL-1	Nonluminescent with a few faint luminescent and Fe-rich cracks.
GB-193-WB	Whole brachiopod.
GB-195	*Gigantoproductus* sp.; Pen-y-Ghent Stream cut SD 8545 7358; Hardlaw Limestone, Early Carboniferous (Visean; Brigantian).
GB-195A-NL-1	Nonluminescent with a few faint luminescent and Fe-rich cracks.
GB-195B-NL-1	Nonluminescent with a few faint luminescent and Fe-rich cracks .
GB-195C-SL-1	Dull luminescence and luminescent cracks included.
GB-195-WB	Whole brachiopod.
GB-199	*Gigantoproductus* sp.; Pen-y-Ghent Stream cut SD 8545 7358; Hardlaw Limestone, Early Carboniferous (Visean; Brigantian).
GB-199-NL-1	Nonluminescent with several faint luminescent cracks.
GB-199-WB	Whole brachiopod.
GB-200	*Gigantoproductus* sp.; Pen-y-Ghent Stream cut SD 8545 7358; Hardlaw Limestone, Early Carboniferous (Visean; Brigantian).
GB-200-SL-1	Dull luminescence and luminescent cracks included.
GB-200-SL-2	Dull luminescence and several luminescent cracks included.
GB-200-WB	Whole brachiopod.
GB-215	Orthostetid; Burlington Coombe, Institute Geological Sciences Sample #2743; Black Rock Limestone, Early Carboniferous (Tournaisian; Hastarian).
GB-215-SL-1	Shell has several luminescent cracks included.
GB-215-NL-1	Nonluminescent, but shell very thin.
GB-216-NL-1	Orthostetid; Burlington Coombe, Institute Geological Sciences Sample #2743; Black Rock Limestone, Early Carboniferous (Tournaisian; Hastarian); Shell badly broken, but luminescent areas avoided(?).
GB-217-NL-1	*Daviesiella* sp.; Burlington Coombe ST 475 582; Burlington Oolite Bed #9, Early Carboniferous (Tournaisian; Hastarian); Nonluminescent with a few minor luminescent cracks included.
GB-236	*Gigantoproductus* sp.; Petershill Reservoir, Bathgate Hills, Scotland; Early Carboniferous (Visean; Asbian-Brigantian).
GB-236A-SL-1	Slightly luminescent along growth banding, some surface silicification.
GB-236A-NL-1	Nonluminescent.
GB-236B-NL-1	Nonluminescent with a few luminescent cracks included.
GB-236-WB	Whole brachiopod.
GB-236-M	Luminescent micritic matrix.
GB-237	*Gigantoproductus* sp.; Petershill Reservoir, Bathgate Hills, Scotland; Early Carboniferous (Visean; Asbian-Brigantian).
GB-237-SL-1	Slight luminescence occurring as thin luminescent cracks.
GB-237-WB	Whole brachiopod.
GB-240	*Gigantoproductus* sp.; Petershill Reservoir, Bathgate Hills, Scotland; Early Carboniferous (Visean; Asbian-Brigantian).
GB-240-NL-1	Nonluminescent with some dull luminescence included.
GB-240-WB	Whole brachiopod.
GB-242	*Gigantoproductus* sp.; Petershill Reservoir, Bathgate Hills, Scotland; Early Carboniferous (Visean; Asbian-Brigantian).
GB-242-SL-1	Dull luminescence throughout area sampled.
GB-242-NL-2	Nonluminescent.

GB-242-SL-3	Dull luminescence and brightly luminescent fibers.
GB-242-WB	Whole brachiopod.
GB-242-M	Luminescent micritic matrix.
GB-245	*Gigantoproductus* sp.; Along sea cliffs north of Benllch, Angelsey, North Wales; Carboniferous Limestone, Early Carboniferous (Visean; Brigantian).
GB-245A-NL-1	Nonluminescent with some dull luminescent areas included; silicified.
GB-245B-NL-1	Nonluminescent with some dull luminescent areas included.
GB-245-WB	Whole brachiopod.
GB-246	*Gigantoproductus* sp.; Along sea cliffs north of Benllch, Angelsey, North Wales; Carboniferous Limestone, Early Carboniferous (Visean; Brigantian).
GB-246A-SL-1	Slight luminescence occurring as thin luminescent cracks.
GB-246A-SL-2	Dull luminescence in area sampled; silicified.
GB-246B-NL-1	Nonluminescent with few thin luminescent cracks.
GB-246-WB	Whole brachiopod.
GB-247	*Gigantoproductus* sp.; Along sea cliffs north of Benllch, Angelsey, North Wales; Carboniferous Limestone, Early Carboniferous (Visean; Brigantian).
GB-247-NL-1	Dull luminescence in area sampled; silicified.
GB-247-WB	Whole brachiopod.
GB-248	*Gigantoproductus* sp.; Along sea cliffs north of Benllch, Angelsey, North Wales; Carboniferous Limestone, Early Carboniferous (Visean; Brigantian).
GB-248A-NL-1	Nonluminescent with a few thin luminescent and Fe-rich cracks.
GB-248B-NL-1	Nonluminescent with some faint luminescent cracks throughout shell.
GB-248-WB	Whole brachiopod.
GB-249	*Gigantoproductus* sp.; Along sea cliffs north of Benllch, Angelsey, North Wales; Carboniferous Limestone, Early Carboniferous (Visean; Brigantian).
GB-249A-SL-1	Slight luminescence along growth banding.
GB-249A-NL-1	Nonluminescent with a few thin luminescent cracks.
GB-249B-SL-1	Dull luminescence with some thin luminescent cracks included.
GB-249-WB	Whole brachiopod.
GB-249-M	Luminescent micritic matrix.
GB-251-SL-1	*Gigantoproductus* sp.; Along sea cliffs north of Benllch, Angelsey, North Wales; Carboniferous Limestone, Early Carboniferous (Visean; Brigantian); Many luminescent and Fe-rich cracks included; silicified.
GB-253-SL-1	*Daviesiella llangollensis*; Tandinas Quarry, Tandinas, Angelsey, North Wales; Early Carboniferous (Visean; Early Asbian); Slight luminescence occurring as several thin luminescent cracks throughout shell.
GB-254	*Daviesiella llangollensis*; Tandinas Quarry, Tandinas, Angelsey, North Wales; Early Carboniferous (Visean; Late Asbian).
GB-254-SL-1	Dull luminescence throughout shell.
GB-254-WB	Whole brachiopod.
GB-255-SL-1	*Daviesiella llangollensis*; Tynant Quarry (Craig Tany), Llangollen, North Wales; Early Carboniferous (Visean; Early Asbian); Dull luminescence throughout shell.
GB-256-SL-1	*Daviesiella llangollensis*; Tynant Quarry (Craig Tany), Llangollen, North Wales; Early Carboniferous (Visean; Early Asbian); Dull luminescence throughout shell, and Fe-rich calcite in cracks; silicified.

GB-259	*Davidsonnina septosa*; Waterswallow Quarry SK 085 753; Early Carboniferous (Visean; Holkerian).
GB-259-1-SL-1	Dull luminescence throughout shell.
GB-259-2-SL-1	Dull luminescence and several luminescent cracks throughout shell.
GB-260	*Daviesiella llangollensis*; Rail cut near Hartington SK 143 617; Early Carboniferous (Visean; Holkerian).
GB-260-1-SL-1	Dull luminescence throughout shell.
GB-260-2-NL-1	Nonluminescent with a few dull luminescent areas included.
GB-261	*Daviesiella llangollensis*; Rail cut near Hartington SK 143 617; Early Carboniferous (Visean; Holkerian).
GB-261-1-SL-1	Dull luminescence throughout shell.
GB-261-2-SL-1	Dull luminescence throughout shell.
GB-261-3-NL-1	Attempted to avoid the pevasive dull luminescence in shell.
GB-262-SL-1	*Cyrtina carbonaria*; Rail cut near Hartington SK 143 617; Early Carboniferous (Visean; Holkerian); Slightly luminescent as luminescent cracks occurring throughout shell.
GB-265-NL-1	*Daviesiella llangollensis*; Eglwseg Rocks near Castell dinus, Royal Scottish Museum #1878.11.8.e, Bran, Llangollen, North Wales; Early Carboniferous (Visean; Asbian); Nonluminescent with some areas of dull luminescence included.
Russia	
Ru-1-NL-1	*Choristites mosquensis* (Fisher); Schturowo/Rjasan, Geol. Inst. Erlangen #Br77; Upper Kohlenkalk, Late Carboniferous (Late Moscovian); Nonluminescent, clear shell, much Fe-rich calcite associated; silicified.
Ru-2-NL-1	*Choristites mosquensis* (Fisher); Schturowo/Rjasan, Geol. Inst. Erlangen #Br77; Upper Kohlenkalk, Late Carboniferous (Late Moscovian); Nonluminescent, clear shell, much Fe-rich calcite associated; silicified.
Ru-3-NL-1	*Choristites mosquensis* (Fisher); Schturowo/Rjasan, Marburg collection #3569; Upper Kohlenkalk, Late Carboniferous (Late Moscovian); Nonluminescent, clear shell, much Fe-rich calcite associated; silicified.
Ru-4-NL-1	*Choristites mosquensis* (Fisher); Schturowo/Rjasan, Marburg collection #3569; Upper Kohlenkalk, Late Carboniferous (Late Moscovian); Nonluminescent, clear shell, much Fe-rich calcite associated; silicified.
Ru-5-NL-1	*Choristites mosquensis* (Fisher); Schturowo/Rjasan, Marburg collection #3569; Upper Kohlenkalk, Late Carboniferous (Late Moscovian); Nonluminescent, clear shell, much Fe-rich calcite associated; silicified.
Ru-6-NL-1	*Choristites mosquensis* (Fisher); Schturowo/Rjasan, Marburg collection #3569; Upper Kohlenkalk, Late Carboniferous (Late Moscovian); Nonluminescent, clear shell, much Fe-rich calcite associated; silicified.
Ru-8-NL-1	*Choristites mosquensis* (Fisher); Schturowo/Rjasan, Marburg collection #3569; Upper Kohlenkalk, Late Carboniferous (Late Moscovian); Nonluminescent, clear shell, much Fe-rich calcite associated; silicified.
Ru-9-NL-1	*Choristites mosquensis* (Fisher); Schturowo/Rjasan, Marburg collection #3569; Upper Kohlenkalk, Late Carboniferous (Late Moscovian);

	Nonluminescent, clear shell, much Fe-rich calcite associated; silicified.
Ru-10-NL-1	*Choristites mosquensis*(Fisher); Schturowo/Rjasan,Marburg Kayser collection 1897; Upper Kohlenkalk, Late Carboniferous (Late Moscovian); Nonluminescent, clear shell, much Fe-rich calcite associated; silicified.
Ru-11-NL-1	*Choristites mosquensis*(Fisher); Schturowo/Rjasan,Marburg Kayser collection 1897; Upper Kohlenkalk, Late Carboniferous (Late Moscovian); Nonluminescent, clear shell, much Fe-rich calcite associated; silicified.
Ru-12-NL-1	*Choristites mosquensis*(Fisher); Schturowo/Rjasan,Marburg collection #1320; Upper Kohlenkalk, Late Carboniferous (Late Moscovian); Nonluminescent, clear shell, much Fe-rich calcite associated; silicified.
Ru-13-NL-1	*Licharewia regulata*(Kutor); Dorf Petschistschi (Wolgal near Kasan); A. Stuckenberg ded; Late Permian (Kazanian); Nonluminescent with few thin luminescent cracks included, some Fe-rich calcite in matrix.
Ru-14	*Licharewia regulata*(Kutor); Dorf Petschistschi (Wolgal near Kasan); A. Stuckenberg ded; Late Permian (Kazanian).
Ru-14-1-NL-1	Nonluminescent.
Ru-14-2-NL-1	Nonluminescent with a few thin luminescent cracks avoided(?).
Ru-15-NL-1	*Licharewia regulata*(Kutor); Gauri 1842; Upper Permian (Kazanian); Nonluminescent, some silicification.
Ru-16-NL-1	*Licharewia regulata*(Kutor); Gauri 1842; Upper Permian (Kazanian); Nonluminescent with some Fe-rich calcite in matrix.
Ru-17-NL-1	*Licharewia regulata*(Kutor); Gauri 1842; Upper Permian (Kazanian); Nonluminescent with some Fe-rich calcite in matrix.

Spain

Province Palencia

E-1	*Choristites*sp.; Mudals in outcrop 500m east of Muda; Late Carboniferous (Bashkirian).
E-1-1-SL-1	Slightly luminescent with a few luminescent cracks, some Fe-rich calcite.
E-1-2-SL-1	Shell has several luminescent cracks and some Fe-rich calcite.
E-1-3-NL-1	Nonluminescent with perhaps a few slightly luminescent cracks.
E-1-4-NL-1	Nonluminescent with perhaps a few slightly luminescent cracks.
E-39-SL-1	*Brachythyrina*sp.; Outcrop along Arroyo de Castilleria River, approximately 3 Km east of Celada de Robeldo; Sierra Corsia Formation, Late Carboniferous (Late Moscovian); Shell has a few minor luminescent cracks and Fe-rich calcite included.
E-42	*Choristites*sp.; Outcrop along Arroyo de Castilleria River, approximately 3 Km east of Celada de Robeldo; Sierra Corsia Formation, Late Carboniferous (Late Moscovian).
E-42-NL-1	Nonluminescent with perhaps some dull luminescent areas included.
E-42-WB	Whole brachiopod.
E-42-M	Luminescent micritic matrix.
E-57-NL-1	*Choristites*sp.; Outcrop along Arroyo de Castilleria River, approximately 3 Km east of Celada de Robeldo; Sierra Corsia Formation, Late Carboniferous (Late Moscovian); Nonluminescent with perhaps a few faint

	luminescent cracks included.
E-62	*Choristites* sp.; Outcrop along Arroyo de Castilleria River, approximately 3 Km east of Celada de Robeldo; Sierra Corsia Formation, Late Carboniferous (Late Moscovian).
E-62A-NL-1	Nonluminescent with perhaps a few luminescent cracks, mostly avoided.
E-62B-NL-1	Nonluminescent.
E-62C-NL-1	Nonluminescent with perhaps a few luminescent cracks, avoided.
E-72-SL-1	*Martinia* sp.; Outcrop on north side of road 20 m southwest of bridge south of Casavegas; Late Carboniferous (Late Moscovian); Many thin luminescent cracks in shell.
E-79-SL-1	*Martinia* sp.; Outcrop on north side of road 20 m southwest of bridge south of Casavegas; Late Carboniferous (Late Moscovian); Many thin luminescent cracks in shell.
E-86-NL-1	*Martinia* sp.; Outcrop on north side of road 20 m southwest of bridge south of Casavegas; Late Carboniferous (Late Moscovian); Many thin luminescent cracks in shell, and Fe-rich calcite.
E-93-NL-1	*Orulgania schulzi*; Outcrop along road 300 m north of Vergano; Vergano Formation, Late Carboniferous (Moscovian); Nonluminescent with perhaps a small luminescent crack included.
E-95	*Orulgania schulzi*; Outcrop along road 300 m north of Vergano; Vergano Formation, Late Carboniferous (Moscovian).
E-95A-NL-1	Nonluminescent with much Fe-rich calcite associated in matrix.
E-95B-NL-1	Nonluminescent with perhaps a few luminescent cracks included.
E-100-NL-1	*Brachythyrina* sp.; Outcrop along road 300 m north of Vergano; Vergano Formation, Late Carboniferous (Moscovian); Nonluminescent except for a small luminescent crack.
E-121	*Choristites* sp.; Outcrop 100 m east of old church in Rabanal de Los Caballeros; Perapertu Formation, Late Carboniferous (Early Moscovian).
E-121-SL-1	Dull luminescence throughout shell.
E-121-WB	Whole brachiopod.
E-122-NL-1	*Choristites* sp.; Outcrop 100 m east of old church in Rabanal de Los Caballeros; Perapertu Formation, Late Carboniferous (Early Moscovian); Nonluminescent with a few luminescent cracks included.
E-124-SL-1	*Reticularia* sp.; Outcrop 100 m east of old church in Rabanal de Los Caballeros; Perapertu Formation, Late Carboniferous (Early Moscovian); Shell has many luminescent and Fe-rich calcite cracks.
E-125-NL-1	*Choristites* sp.; Outcrop 100 m east of old church in Rabanal de Los Caballeros; Perapertu Formation, Late Carboniferous (Early Moscovian); Nonluminescent with perhaps a few luminescent cracks.
E-126-NL-1	*Choristites* sp.; Outcrop 100 m east of old church in Rabanal de Los Caballeros; Perapertu Formation, Late Carboniferous (Early Moscovian); Nonluminescent with perhaps a few luminescent cracks.
E-127-NL-1	*Choristites* sp.; Outcrop 100 m east of old church in Rabanal de Los Caballeros; Perapertu Formation, Late Carboniferous (Early Moscovian);

	Nonluminescent with perhaps a few luminescent cracks.
E-129-NL-1	*Choristites* sp.; Outcrop 100 m east of old church in Rabanal de Los Caballeros; Perapertu Formation, Late Carboniferous (Early Moscovian); Nonluminescent with perhaps a few luminescent cracks.
E-132-NL-1	*Brachythyrina* sp.; Outcrop 100 m east of old church in Rabanal de Los Caballeros; Perapertu Formation, Late Carboniferous (Early Moscovian); Nonluminescent.
E-134-Sl-1	*Brachythyrina* sp.; Outcrop 100 m east of old church in Rabanal de Los Caballeros; Perapertu Formation, Late Carboniferous (Early Moscovian); Shell has many luminescent cracks included.
E-135	*Brachythyrina* sp.; Outcrop 100 m east of old church in Rabanal de Los Caballeros; Perapertu Formation, Late Carboniferous (Early Moscovian).
E-135A-SL-1	Shell has a few luminescent cracks included.
E-135B-NL-1	Nonluminescent with perhaps a couple luminescent cracks included.
E-135C-NL-1	Nonluminescent with a few luminescent cracks included.
E-138	*Brachythyrina* sp.; Mina Eugenia, north of Santa Maria de Rodondo; Barruelo Formation, Late Carboniferous (Early Kasimovian).
E-138-SL-1	Shell has a few luminescent cracks.
E-138-WB	Whole brachiopod.
E-142	*Brachythyrina* sp.; Mina Eugenia, north of Santa Maria de Rodondo; Barruelo Formation, Late Carboniferous (Early Kasimovian).
E-142-NL-1	Nonluminescent with perhaps a couple faint luminescent cracks.
E-142-WB	Whole brachiopod.

Province Leon

E-158	*Choristites* sp.; Outcrop along the Rio Currueno in the Curueno Valley, southeast of Valdeteja; Valdeteja Formation (Bashkirian).
E-158A-NL-1	Nonluminescent with major cracks avoided but some nonluminescent Fe-rich cracks included.
E-158B-NL-1	Nonluminescent with major cracks avoided(?).
E-160-NL-1	*Choristites* sp.; Outcrop along the Rio Currueno in the Curueno Valley, southeast of Valdeteja; Valdeteja Formation Late Carboniferous (Bashkirian); Dull luminescence throughout shell and some Fe-rich calcite included.
E-162-NL-1	*Choristites* sp.; Outcrop along the Rio Currueno in the Curueno Valley, southeast of Valdeteja; Valdeteja Formation Late Carboniferous (Bashkirian); Nonluminescent.
E-163-NL-1	*Choristites* sp.; Outcrop along the Rio Currueno in the Curueno Valley, southeast of Valdeteja; Valdeteja Formation, Late Carboniferous (Bashkirian); Nonluminescent shell with a few luminescent cracks included.
E-166-NL-1	*Choristites* sp.; Outcrop along the Rio Currueno in the Curueno Valley, southeast of Valdeteja; Valdeteja Formation , Late Carboniferous (Bashkirian); Nonluminescent with perhaps a few luminescent cracks included.
E-178-NL-1	*Choristites* sp.; Outcrop along stream at bridge on main road 200 m east of Valdeteja; Valdeteja Formation, Late Carboniferous (Bashkirian);

	Nonluminescent with perhaps a few luminescent cracks included.
E-179	*Choristites* sp.; Outcrop along country road 200 m north of Barrio de La Jerica; Louis Ciruera Formation, Late Carboniferous (Moscovian).
E-179A-NL-1	Nonluminescent except for a few thin luminescent cracks.
E-179B-NL-1	Nonluminescent.
E-179C-NL-1	Nonluminescent with several thin slightly luminescent cracks.
E-180-NL-1	*Choristites* sp.; Outcrop along country road 200 m north of Barrio de La Jerica; Louis Ciruera Formation, Late Carboniferous (Moscovian); Nonluminescent except for a few luminescent cracks.
E-181-SL-1	*Choristites* sp.; Outcrop along country road 200 m north of Barrio de La Jerica; Louis Ciruera Formation, Late Carboniferous (Moscovian); Slightly luminescent occurring as several thin luminescent cracks, some matrix included.
E-182	*Choristites* sp.; Outcrop along country road 200 m north of Barrio de La Jerica; Louis Ciruera Formation, Late Carboniferous (Moscovian).
E-182A-NL-1	Nonluminescent with some minor luminescent cracks included.
E-182B-NL-1	Nonluminescent with perhaps a few thin luminescent cracks.
E-183-NL-1	*Choristites* sp.; Outcrop along country road 200 m north of Barrio de La Jerica; Louis Ciruera Formation, Late Carboniferous (Moscovian); Nonluminescent with a couple minor luminescent cracks.
E-185-NL-1	*Choristites* sp.; Outcrop along country road 200 m north of Barrio de La Jerica; Louis Ciruera Formation, Late Carboniferous (Moscovian); Nonluminescent with a couple minor luminescent cracks.
E-187	*Choristites* sp.; Outcrop along country road 200 m north of Barrio de La Jerica; Louis Ciruera Formation, Late Carboniferous (Moscovian).
E-187A-SL-1	Nonluminescent but penetrated brightly luminescent zone.
E-187B-NL-1	Nonluminescent with a couple luminescent cracks.
E-189-NL-1	*Choristites* sp.; Outcrop along country road 200 m north of Barrio de La Jerica; Louis Ciruera Formation, Late Carboniferous (Moscovian); Nonluminescent except for a couple minor luminescent cracks.

Province Oviedo

E-226-SL-1	Reticulariacean; Latores Quarry west of Latores; Late Carboniferous (Bashkirian); Several small luminescent cracks included.
E-234-NL-1	*Choristites* sp.; Along coast northeast of Hontoria; Eslalada Formation; Late Carboniferous (Moscovian); Nonluminescent with some minor luminescent cracks penetrated.
E-236-NL-1	*Choristites* sp.; Along coast northeast of Hontoria; Eslalada Formation; Late Carboniferous (Moscovian); Nonluminescent with some minor luminescent cracks.
E-246	*Choristites* sp.; Along coast northeast of Hontoria; Eslalada Formation;

	Late Carboniferous (Moscovian).
E-246A-NL-1	Nonluminescent.
E-246B-NL-1	Nonluminescent.
E-251-NL-1	*Choristites* sp.; Along coast northeast of Hontoria; Eslalada Formation; Late Carboniferous (Moscovian); Nonluminescent with some minor luminescent cracks.
E-252-NL-1	*Brachythyrina* sp.; Along coast northeast of Hontoria; Eslalada Formation; Late Carboniferous (Moscovian); Nonluminescent with a few minor luminescent cracks.
E-255-NL-1	*Choristites* sp.; Along coast northeast of Hontoria; Eslalada Formation; Late Carboniferous (Moscovian); Nonluminescent.
E-281-NL-1	*Choristites* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian); Nonluminescent except for a few luminescent cracks.
E-282-NL-1	*Martinia* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian); Nonluminescent, perhaps some matrix included.
E-287-NL-1	*Martinia* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian); Nonluminescent with some minor luminescent cracks .
E-289-NL-1	*Choristites* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian); Nonluminescent with a few luminescent cracks.
E-290-NL-1	*Choristites* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian); Nonluminescent with perhaps a few minor luminescent cracks.
E-292	*Choristites* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian).
E-292A-SL-1	Dull luminescence and some Fe-rich calcite .
E-292B-NL-1	Nonluminescent except for a few minor luminescent cracks.
E-293	*Choristites* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian).
E-293A-SL-1	Dull luminescent area sampled.
E-293B-NL-1	Nonluminescent with a few minor luminescent cracks.
E-311-SL-1	*Choristites* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian); Nonluminescent but a brightly luminescent zone penetrated during drilling.
E-315-NL-1	*Choristites* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian); Nonluminescent with a couple minor luminescent cracks.
E-317-NL-1	*Choristites* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian); Nonluminescent.
E-321-NL-1	*Choristites* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian); Nonluminescent.
E-322	*Choristites* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes;

	Picos Formation, Late Carboniferous (Kasimovian).
E-322-NL-1	Nonluminescent with a couple minor luminescent cracks.
E-322-WB	Whole brachiopod.
E-323	*Choristites* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian).
E-323-NL-1	Nonluminescent.
E-323-NL-2	Nonluminescent with perhaps a minor luminescent crack included.
E-323-WB	Whole brachiopod.
E-323-M	Luminescent micritic matrix.
E-324	*Choristites* sp.; Minas Mazarrasa, approximately 10 Km north of Sortes; Picos Formation, Late Carboniferous (Kasimovian).
E-324A-NL-1	Nonluminescent.
E-324A-NL-2	Nonluminescent.
E-324A-NL-3	Nonluminescent.
E-324A-NL-4	Nonluminescent.
E-323A-NL-5	Nonluminescent.
E-324B-NL-1	Nonluminescent.
E-324C-NL-1	Nonluminescent.
E-324D-NL-1	Nonluminescent.
E-324E-NL-1	Nonluminescent.
E-324F-NL-1	Nonluminescent.
E-324G-NL-1	Nonluminescent.
E-324H-NL-1	Nonluminescent.
E-324I-NL-1	Nonluminescent.
E-324J-NL-1	Nonluminescent.
E-324J-NL-1	Nonluminescent.
E-324K-NL-1	Nonluminescent.
E-324-WB	Whole brachiopod.
E-324-M	Luminescent micritic matrix.
E-327	*Choristites* sp.; Outcrop 200 m north of Resoba, Palencia, Resoba Limestone, Early Carboniferous (Late Serpukhovian).
E-327A-NL-1	Nonluminescent.
E-327B-NL-1	Nonluminescent with a few minor luminescent cracks included.
E-327-WB	Whole brachiopod.
E-331-NL-1	*Choristites* sp.; Roadcut north of San Emiliano on road to Candemuela, Province Leon; San Emiliano Formation, Late Carboniferous (Early Moscovian); Nonluminescent with some minor luminescent cracks.
E-334-NL-1	*Choristites* sp.; Roadcut north of San Emiliano on road to Candemuela, Province Leon; San Emiliano Formation, Late Carboniferous (Early Moscovian); Nonluminescent with perhaps a luminescent crack.

Thailand

Th-1-SL-1	*Neospirifer* sp.; K 263 E=40802 N=213425, Late Carboniferous or Early Permian; Dull luminescence throughout shell with several thin luminescent cracks.

Timor

Ti-6	*Spiriferella*sp.; Village of Tubulopo, Early Permian (Kungurian).
Ti-6-SL-1	Dull luminescence with several luminescent and Fe-rich cracks.
Ti-6-WB	Whole brachiopod.
Ti-7	*Spiriferella*sp.; Village of Tubulopo, Early Permian (Kungurian).
Ti-7-NL-1	Nonluminescent with a few luminescent cracks.
Ti-7-NL-2	Nonluminescent with a few luminescent cracks.
Ti-7-WB	Whole brachiopod.
Ti-8	*Spiriferella*sp.; Village of Tubulopo, Early Permian (Kungurian).
Ti-8-NL-1	Nonluminescent with a few luminescent cracks.
Ti-8-BL-2	Brightly luminescent.
Ti-8-SL-3	Patchy nonluminescent and brightly luminescent.
Ti-8-WB	Whole brachiopod.
Ti-9	*Spiriferella*sp.; Village of Tubulopo, Early Permian (Kungurian).
Ti-9-SL-1	Luminescent material included during drilling.
Ti-9-WB	Whole brachiopod.
Ti-12-SL-1	*Spirifer fasciler*; Village of Niki-Niki; Early Permian (Kungurian); Several luminescent cracks included.
Ti-16-SL-1	*Spirifer fasciler*; Village of Niki-Niki; Early Permian (Kungurian); Several luminescent cracks included.
Ti-19-SL-1	*Stenoscisma*sp.; Village of Baselo; Early Permian (Kungurian); Several luminescent cracks included.
Ti-26	*Stenoscisma*sp.; Village of Niki-Niki; Early Permian (Kungurian);
Ti-26-NL-1	Nonluminescent.
Ti-26-WB	Whole brachiopod.
Ti-33-NL-1	*Phriconothyrididae*sp.; Village of Baselo; Early Permian (Kungurian); Nonluminescent with a few minor luminescent cracks included.
Ti-44	*Spirifer cristata*; Village of Baselo; Early Permian (Kungurian).
Ti-44-NL-1	Nonluminescent.
Ti-44-WB	Whole brachiopod.
Ti-50-NL-1	*Cauiaophoria firdouis*; Village of Diverses; Early Permian (Kungurian); Nonluminescent.
Ti-52-NL-1	*Cauiaophoria firdouis*; Village of Diverses; Early Permian (Kungurian); Nonluminescent except for a few luminescent cracks.
Ti-54	*Cauiaophoria firdouis*; Village of Pausokah; Early Permian (Kungurian).
Ti-54-SL-1	Several luminescent cracks included.
Ti-54-WB	Whole brachiopod.
Ti-67	*Camarophoria purdoni*; Village of Fatu Tuanini, Early Permian (Kungurian).
Ti-67A-NL-1	Nonluminescent except for a few minor luminescent cracks.
Ti-67B-NL-1	Nonluminescent with perhaps one minor luminescent crack.
Ti-67-WB	Whole brachiopod.
Ti-80	*Martinia*sp.; Village of Kioeuoko, Early Permian (Kungurian).

Ti-80-NL-1	Nonluminescent.
Ti-80-WB	Whole brachiopod.
Ti-82	*Martinia*sp.; Village of Kioeuoko, Early Permian (Kungurian).
Ti-82-NL-1	Nonluminescent
Ti-82-SL-2	Several luminescent cracks included.
Ti-82-IC-3	Luminescent internal blocky cement.
Ti-82-IC-4	Luminescent internal blocky cement.
Ti-82-WB	Whole brachiopod.
Ti-83	*Martinia*sp.; Village of Kioeuoko, Early Permian (Kungurian).
Ti-83A-NL-1	Nonluminescent.
Ti-83B-NL-1	Nonluminescent.
Ti-83B-NL-2	Nonluminescent.
Ti-83B-NL-3	Nonluminescent.
Ti-83B-IC-4	Luminescent internal blocky cement.
Ti-83-WB	Whole brachiopod.
Ti-83-M	Dull luminescence in micritic matrix.
Ti-84	*Martinia*sp.; Village of Kioeuoko, Early Permian (Kungurian).
Ti-84-NL-1	Nonluminescent with some minor luminescent cracks included.
Ti-84-WB	Whole brachiopod.
Ti-90-NL-1	*Martinia*sp.; Village of Pauseokah, Early Permian (Kungurian); Nonluminescent.
Ti-93	*Martinia*sp.; Village of Pauseokah, Early Permian (Kungurian).
Ti-93-NL-1	Nonluminescent except for a few minor luminescent cracks.
Ti-93-WB	Whole brachiopod.
Ti-97-NL-1	*Camarophoria purdoni*; Village of Broidi; Early Permian (Kungurian); Nonluminescent.
Ti-98	*Camarophoria purdoni*; Village of Broidi; Early Permian (Kungurian).
Ti-98-SL-1	Dull luminescence with luminescent and Fe-rich cracks.
Ti-98-WB	Whole brachiopod.
Ti-99-SL-1	*Camarophoria purdoni*; Village of Broidi; Early Permian (Kungurian); Shell has some luminescent cracks but lots of Fe-oxides associated.
Ti-103-SL-1	*Spirifer lineatus*; Village of Baselo; Early Permian (Kungurian); Shell has many luminescent and Fe-rich cracks.
Ti-114	*Spirifer rajah*; Village of Baselo, Early Permian (Kungurian).
Ti-114-NL-1	Nonluminescent with a few minor luminescent cracks.
Ti-114-WB	Whole brachiopod.
Ti-115	*Spirifer rajah*; Village of Baselo, Early Permian (Kungurian).
Ti-115A-NL-1	Nonluminescent.
Ti-115B-NL-1	Nonluminescent.
Ti-116-NL-1	*Spirifer lineatus*; Village of Fatu Tuanini; Early Permian (Kungurian); Nonluminescent with a few minor luminescent cracks.
Ti-123-SL-1	*Spirigera royssii*; Village of Koeka; Early Permian (Kungurian); Dull luminescence throughout shell.
Ti-126-SL-1	*Spirigera royssii*; Village of Koeka; Early Permian (Kungurian); Dull luminescence throughout shell and some Fe-rich calcite as well as some

	silicification.
Ti-127	*Spirigera royssii*; Village of Koeka; Early Permian (Kungurian).
Ti-127A-SL-1	Nonluminescent with some luminescent cracks and silicification.
Ti-127B-SL-1	Nonluminescent with some luminescent cracks and silicification.
Ti-131-SL-1	*Spirigera timoreusis*; Village of Fatu Tuanini; Early Permian (Kungurian); Nonluminescent with some luminescent cracks and some silicification.
Ti-135	*Spirigera timoreusis*; Village of Fatu Tuanini; Early Permian (Kungurian).
Ti-135A-NL-1	Nonluminescent
Ti-135B-NL-1	Nonluminescent with perhaps a few minor luminescent cracks.

Turkey

Tu-3-SL-1	Spirifer; N. Sariz Antolia, Geol. Inst. Erlangen sample # 1971; Middle Permian; Nonluminescent with several luminescent cracks.
Tu-7-SL-1	Spirifer; N. Sariz Antolia, Geol. Inst. Erlangen sample # 1971; Middle Permian; Nonluminescent with several luminescent cracks.

Yugoslavia

Yu-1-SL-1	Spirifer; Pocivala 1, Lavorniski, Rovt, Karavanke Mountains; Auernig Formation, Late Carboniferous (Gshelian); Several luminescent cracks through shell.
Yu-2-SL-1	Spirifer; Pocivala 1, Lavorniski, Rovt, Karavanke Mountains; Auernig Formation, Late Carboniferous (Gshelian); Several luminescent cracks through shell.
Yu-3-SL-1	Spirifer; Crni Vrh, Karavanke Mountains; Auernig Formation, Late Carboniferous (Gshelian); Several luminescent cracks through shell.
Yu-5-SL-1	Spirifer; Na Visokin, Devje, Karavanke Mountains; Auernig Formation, Late Carboniferous (Gshelian); Several luminescent cracks through shell.
Yu-6-SL-1	Spriferida; Southwest of Presusnik Ravne, Karavanke Mountains; Clastic Trogkofel Formation, Early Permian (Sakmarian-Artinskian); Several luminescent cracks included.
Yu-8-NL-1	*Martinia* sp.; Na Peceh, Karavanke Mountains; Clastic Trogkofel Formation, Early Permian (Sakmarian-Artinskian); Nonluminescent with a few minor luminescent cracks.
Yu-9	*Martinia* sp.; Na Peceh, Karavanke Mountains; Clastic Trogkofel Formation, Early Permian (Sakmarian-Artinskian).
Yu-9A-NL-1	Nonluminescent.
Yu-9B-NL-1	Nonluminescent with a few minor luminescent cracks.
Yu-10-SL-1	*Scacchinella gigantus*; Ortnek, S. Solivina, Karavanke Mountains; Clastic Trogkofel Formation, Early Permian (Sakmarian-Artinskian); Shell has several luminescent cracks.
Yu-22-SL-1	Spirifer; Dolzanova steska, Karavanke Mountains; Calstic Trogkofel

	Formation, Early Permian (Sakmarian-Artinskian; Dull luminescence with some luminescent and Fe-rich cracks.
Yu-24-NL-1	Spirifer; Ravne Douje, Karavanke Mountains; Clastic Trogkofel Formation, Early Permian (Sakmarian-Artinskian); Nonluminescent with several luminescent cracks.
Yu-25-SL-1	Spirifer; Ravne Douje, Karavanke Mountains; Clastic Trogkofel Formation, Early Permian (Sakmarian-Artinskian); Shell has several luminescent cracks.
Yu-26-NL-1	Spirifer; Ravne Douje, Karavanke Mountains; Clastic Trogkofel Formation, Early Permian (Sakmarian-Artinskian); Nonluminescent with several minor luminescent cracks.
Yu-27-SL-1	Spirifer; Ravne Douje, Karavanke Mountains; Clastic Trogkofel Formation, Early Permian (Sakmarian-Artinskian); Several luminescent cracks included.
Yu-28-NL-1	Spirifer; Ravne Douje, Karavanke Mountains; Clastic Trogkofel Formation, Early Permian (Sakmarian-Artinskian); Nonluminescent with some minor luminescent cracks included.
Yu-30-SL-1	Spirifer; Ravne Douje, Karavanke Mountains; Clastic Trogkofel Formation, Early Permian (Sakmarian-Artinskian); Several luminescent cracks included.
Yu-34-SL-1	Spirifer; Straza Bled, Julian Alps; Neoschwagerinia Limestone, Middle Permian; Several luminescent cracks included.
Yu-40	*Tyloplecta richthoffeni*; Vrzdenec, near Ljubljana; Vazar Formation; Late Permian.
Yu-40A-SL-1	Several luminescent and Fe-rich cracks included.
Yu-40B-SL-1	Several luminescent and Fe-rich cracks included.
Yu-46-NL-1	Spirifer; Dolzanova soteska, Karavanke Mountains; Clastic Trogkefel Formation, Early Permian (Sakmarian-Artinskian); Nonluminescent with several luminescent cracks included.
Ord-1	*Platystrophia acutilinata*; Richmond Fm., 3.5 mi S. of Richmond Indiana; Late Ordovician (Ashgillian).
Ord-1-1-SL-1	Few slightly luminescent cracks included.
Ord-1-2-SL-1	Few slightly luminescent cracks included.
Ord-1-3-SL-1	Very few slightly luminescent cracks included.
Ord-2-NL-1	*Herbertella sinualata* (Hall); Richmond Fm., Centerville, Ohio; Late Ordovician (Ashgillian); nonluminescent.
Ord-4-NL-1	*Arthis fiforata* (var. *acatilirata*); Richmond Fm., Cincinnati, Ohio; Late Ordovician (Ashgillian); nonluminescent.
Ord-5	*Rhynchotreta cupax*; Richmond Fm., G2-Upper road cut, Madison, Indiana; Late Ordovician (Ashgillian).
Ord-5-1-NL-1	Nonluminescent.
Ord-5-2-NL-1	Nonluminescent.
Ord-5-3-NL-1	Nonluminescent.
Ord-5-4-NL-1	Nonluminescent.
Ord-6	Composite Whole Brachiopods; Richmond Fm., G2-Upper road cut, Madison, Indiana; Late Ordovician (Ashgillian).

HH(84)-1-NL-1 *Mucrospirifer thedfordensis*; Hungry Hollow Fm., Arkona, Ontario, Canada; Middle Devonian (Givetian); Some luminescent cracks, avoided.

HH(84)-2-NL-1 *Mucrospirifer thedfordensis*; Hungry Hollow Fm., Arkona, Ontario, Canada; Middle Devonian (Givetian); nonluminescent.

HH(84)-3-NL-1 *Mucrospirifer thedfordensis*; Hungry Hollow Fm., Arkona, Ontario, Canada; Middle Devonian (Givetian); Some luminescent cracks, avoided.

HH(84)-4-NL-1 *Mucrospirifer thedfordensis*; Hungry Hollow Fm., Arkona, Ontario, Canada; Middle Devonian (Givetian); Some luminescent cracks, avoided.

HH(84)-5-NL-1 *Mucrospirifer thedfordensis*; Hungry Hollow Fm., Arkona, Ontario, Canada; Middle Devonian (Givetian); nonluminescent.

HH(84)-6-NL-1 *Mucrospirifer thedfordensis*; Hungry Hollow Fm., Arkona, Ontario, Canada; Middle Devonian (Givetian); Some luminescent cracks included.

HH(84)-7-NL-1 *Mucrospirifer thedfordensis*; Hungry Hollow Fm., Arkona, Ontario, Canada; Middle Devonian (Givetian); Some luminescent cracks included.

HH(84)-8-NL-1 *Mucrospirifer thedfordensis* (composite whole brachiopods); Hungry Hollow Fm., Arkona, Ontario, Canada; Middle Devonian (Givetian).

APPENDIX D

ELEMENTAL AND OXYGEN AND CARBON ISOTOPIC DATA

All elemental values are in ppm, and isotopic values are in per mil relative to PDB. Dilute acid insoluble residue values (IR) are in percent. Luminescent character (LC) values represents a visual estimate of the relative amount of luminescent material in a shell (see Appendix B for explanation and Appendix C for description of luminescent character in each shell). See Appendix A for explanation of sample numbering scheme and Appendix C for locality information and taxonomic identification. (Elemental values should be rounded off to the nearest ≈20-100 ppm and isotopic values to nearest 0.1‰; see text for analytical uncertainty).

Sample	LC	% IR	Mg	Mn	Fe	Sr	$\delta^{18}O$	$\delta^{13}C$
Af-1-1-NL-1	1	0.7	1319	16	49	1213	-2.72	+4.44
Af-1-2-SL-1	3	0.8	1413	17	81	2410	-3.31	+4.11
Af-6-SL-1	3	0.0	3967	53	296	1451	-7.28	+2.15
Af-7-SL-1	2	0.0	1600	37	245	282	-9.44	+0.49
Af-8-NL-1	2	0.5	930	9	95	1674	-3.59	+2.89
Af-9-NL-1	2	0.0	570	15	106	1284	-1.33	+3.67
Af-10-NL-1	2	0.5	1643	20	85	2297	-3.94	+5.00
Af-12-SL-1	3	0.0	816	59	137	2219	-2.93	+3.61
Af-27-NL-1	1	0.0	447	9	26	630	-2.33	+5.23
Al-1-NL-1	2	1.9	3418	47	617	1424	-0.91	+3.01
Al-1-NL-2	2	1.2	3790	29	352	1635	-1.47	+2.94
Al-1-NL-3	2	1.1	4037	19	310	1915	-1.51	+2.87
Al-1-NL-4	2	1.4	4178	28	435	1826	-2.40	+1.88
Al-1-NL-5	2	1.2	4460	25	344	1935	-1.90	+2.98
Al-1-NL-6	2						-1.79	+3.09
Al-1-NL-7	2						-2.05	+3.13
Al-1-NL-8	2	9.4	5208	26	807	1458	-1.45	+3.25
Al-1-NL-9	2	10.0	4365	79	2222	1071	-1.28	+3.41
Al-1-WB		0.2	4292	24	161	1753	-4.12	+3.06
Al-2-NL-1	2	0.0	5763	24	146	2638	-2.41	+3.00
Al-2-WB		0.5	4470	309	192	1661	-3.54	+1.28
Al-3A-NL-1	1	0.3	4486	14	37	1630	-1.33	+3.31
Al-3B-NL-1	1	0.0	6175	27	14	1981	-1.01	+3.31
Al-3B-NL-2	1	3.3	5365	32	11	1470	-1.29	+3.42
Al-3-WB		0.7	4297	41	171	1596	-1.66	+3.09
Al-4-NL-1	2	1.8	5656	23	108	2369	-1.41	+3.65
Al-4-WB		0.4	4924	152	250	1652	-1.57	+3.03

A1-4-WB							-2.14	+2.88
A1-5A-NL-1	1	2.2	4857	24	0	1799	-1.23	+3.14
A1-5A-SL-2	3	3.6	5297	113	14	1591	-1.79	+2.75
A1-5A-BL-3	4	1.1	4025	415	60	1322	-5.02	+0.58
A1-5B-BL-1	4						-4.81	+0.09
A1-5B-BL-2	4	0.0	3700	633	300	367	-5.61	+0.18
A1-5B-BL-3	4	3.4	2344	227	838	384	-6.04	+0.04
A1-5B-NL-4	2	4.2	5652	72	978	1123	-1.28	+3.10
A1-5B-NL-5	1	0.0	4455	25	50	1176	-1.10	+3.42
A1-5B-NL-6	2	0.0	14250	100	550	3450	-1.11	+3.17
A1-5B-NL-7	2	0.3	5410	50	254	1164	-1.29	+3.37
A1-5B-BL-8	4	0.0	3479	155	644	515	-5.49	+0.16
A1-5B-BL-9	4	0.0	3730	159	40	1111	-5.90	+0.16
A1-5-WB		1.0	5181	278	69	1547	-2.96	+1.85
A1-6-NL-1	2	0.0	1308	54	163	1538	-2.04	+2.94
A1-6-WB		1.9	1508	102	240	1839	-2.08	+2.44
A1-7-SL-1	3	0.9	1258	39	338	2100	-2.26	+2.41
A1-8-NL-1	2	0.3	1558	33	182	1481	-2.06	+2.94
A1-8-WB		3.4	1482	310	316	1738	-2.72	+1.79
A1-9-NL-1	2	0.3	1180	26	112	1393	-1.66	+2.86
A1-11-SL-1	3	1.8	1510	54	92	1357	-2.50	+3.02
A1-12-SL-1	3	0.0	1492	40	105	1497	-1.73	+2.67
A1-13-SL-1	3	1.1	931	78	118	1336	-2.01	+2.74
A1-13-SL-2	3	0.0	1112	57	5	1231	-1.83	+2.40
A1-13-WB		3.5	1133	211	102	1428	-1.95	+2.51
A-66-WB		0.0	50697	1718	2005	75	-8.37	+1.71
A-68-WB							-9.36	+2.50
A-69-WB		2.9	3561	162	184	1131	-8.60	+2.74
A-70-WB		4.1	3590	344	332	1286	-11.95	+2.82
B-1A-NL-1	1	0.0	4063	14	97	1653	-3.50	+2.39
B-1B-NL-1	1	0.0	3229	6	53	1988	-3.25	+1.50
B-1B-NL-2	1	0.0	3320	12	53	1868	-3.30	+2.12
B-1-WB		0.0	4116	6	111	1423	-3.26	+3.02
B-1-WB							-3.37	+2.94
B-11-NL-1	2	0.0	4317	13	90	2126	-2.84	+3.38
B-11-WB		1.2	4335	6	81	1555	-3.02	+3.30
B-11-WB							-3.87	+2.83
B-11-WB							-3.00	+3.27
B-14A-NL-1	1	0.0	3897	0	20	1511	-2.87	+3.20
B-14A-SL-2	2	2.7	3788	12	52	1469	-3.17	+2.96
B-14A-M		1.0	3084	83	98	578	-4.79	+1.55
B-14B-SL-1	2	1.1	3908	13	54	1586	-3.08	+2.53
B-14B-NL-2	1	1.2	3902	0	15	1423	-2.90	+2.93
B-14B-M		1.3	3273	75	0	503	-4.71	+1.43
B-14C-NL-1	1	0.6	3920	19	147	933	-2.81	+2.99
B-14C-NL-2	1	0.4	3503	20	0	1063	-2.58	+3.26

B-14C-NL-3	2	1.1	3837	12	127	759	-3.04	+2.32
B-14C-NL-4	2	0.0	3889	26	372	816	-3.76	+2.14
B-14D-NL-1	2	0.9	3937	15	250	843	-3.04	+2.86
B-14D-NL-2	2	2.1	3555	15	187	621	-2.67	+3.10
B-14D-NL-3	1	1.8	3719	27	97	742	-2.78	+3.00
B-14D-NL-4	1	4.5	4060	15	116	1299	-3.65	+2.01
B-14E-NL-1	1	1.5	3577	22	162	782	-3.00	+2.79
B-14E-NL-2	2	1.7	3460	14	268	946	-2.81	+2.91
B-14E-NL-3	1	1.1	3617	7	105	1264	-3.25	+2.20
B-14E-NL-4	2	1.6	3765	31	183	980	-3.93	+2.44
B-14F-NL-1	1	1.0	3762	14	126	1789	-2.97	+2.95
B-14F-NL-2	1	0.9	3893	19	127	1796	-2.68	+3.05
B-14F-NL-3	1	1.2	3787	18	129	2173	-3.07	+2.58
B-14F-NL-4	1	0.7	4001	14	162	2012	-3.96	+1.11
B-14F-NL-5	1	0.8	4043	17	97	1062	-3.68	+2.49
B-14-WB		2.0	4135	57	0	1465	-3.11	+2.46
B-15A-NL-1	2	1.5	5452	33	38	1433	-3.29	+3.09
B-15A-SL-2	3	0.8	5419	35	55	1593	-3.02	+2.85
B-15B-NL-1	2	0.0	4282	10	83	2466		
B-15-WB		1.0	5499	38	0	1593	-3.19	+2.92
B-15-M		1.3	4395	109	310	610	-6.25	-3.55
B-21-SL-1	2	0.0	4534	22	44	1850	-3.41	+2.96
B-21-WB		0.2	3839	12	128	1822	-3.19	+2.95
B-38-SL-1	3	0.9	3547	68	151	858	-4.31	-0.99
B-38-WB		0.8	3184	72	93	715		
B-41-SL-1	3	2.5	3309	72	192	593	-4.77	-0.46
B-41-WB		0.6	2978	70	239	478	-4.87	+0.07
B-67-WB		0.0	2739	216	350	396		
B-113-BL-1	4	4.2	5578	32	491	1994	-10.94	-3.12
DDR-1-SL-1	3	0.0	1688	130	682	1429	-1.74	+4.34
F-1-WB		2.8	4188	18	130	1700	-4.96	-0.36
F-2-SL-1	3	0.0	5155	21	1014	1923	-2.86	+1.64
F-2-WB		2.5	5507	33	177	1775	-3.03	+2.05
GB-12-SL-1	3	0.8	5626	37	271	4118	-4.54	-1.22
GB-30-WB		0.9	5547	465	2153	1435	-5.37	+1.97
GB-33A-NL-1	2	0.0	5731	54	25	2229	-4.51	+2.70
GB-33B-SL-1	2	0.0	5816	45	129	2082	-4.64	+2.10
GB-33-WB		0.0	5144	114	595	1797	-4.61	+2.54
GB-35-SL-1	3	0.0	6333	83	333	1847	-5.01	-1.91
GB-35-WB		6.6	4746	266	911	1742	-5.82	-4.97
GB-35-WB							-5.68	-3.19
GB-67A-NL-1	2	0.0	3502	16	52	2234	-3.85	+0.84
GB-67B-SL-1	3	0.6	3935	23	53	2289	-4.71	+0.01
GB-67-WB		1.3	2954	74	51	1400	-5.12	+1.08
GB-75A-NL-1	2	4.2	3878	8	32	2378	-4.07	+0.50

GB-75B-SL-1	3	0.0	3282	37	50	2078	-3.57	+1.64
GB-75-WB		2.9	2742	93	149	1297	-3.80	+1.23
GB-79-1-NL-1	1	0.0	506	19	66	656	-1.93	+3.96
GB-79-2-NL-1	1	0.0	639	16	41	705	-1.89	+3.52
GB-79-3-NL-1	1	0.7	498	9	34	893	-2.05	+3.48
GB-79-4-NL-1	1	0.0	771	7	49	882	-1.99	+3.85
GB-79-5-NL-1	1	0.6	738	8	48	793	-2.04	+3.65
GB-79-6-NL-1	1						-1.83	+3.62
GB-100-SL-1	2	1.7	3660	79	123	908	-4.64	-0.34
GB-102-SL-1	3	0.0	3894	47	187	981	-3.71	-1.93
GB-104-SL-1	3	0.3	3252	61	169	744	-6.47	+0.70
GB-173-SL-1	3	0.9	4474	75	120	1201	-5.86	+3.10
GB-174A-SL-1	2	0.9	4027	85	154	1206	-5.73	+3.54
GB-174B-SL-1	3	0.0	5694	65	382	1065	-6.13	+2.69
GB-174C-SL-1	3	4.9	4167	128	282	1244	-6.10	+3.04
GB-175-SL-1	3	0.5	4864	68	159	1814	-6.46	+2.61
GB-177-SL-1	3	0.5	4256	69	117	895	-4.86	+3.33
GB-180-NL-1	1						-1.84	+4.63
GB-192-NL-1	2	0.0	3108	20	94	2166	-3.51	+2.09
GB-192-WB		0.0	3123	15	137	1735	-3.37	+2.27
GB-193-NL-1	2	0.0	3008	14	137	1785	-3.16	+2.36
GB-193-WB		0.5	3498	6	193	1609	-3.00	+2.58
GB-195A-NL-1	2	1.5	3638	30	90	2036	-3.08	+2.42
GB-195B-NL-1	2	0.0	3182	21	146	1714	-3.22	+2.28
GB-195C-SL-1	2	1.1	2652	15	87	2088	-2.94	+2.10
GB-195-WB		1.6	3156	12	166	1537	-3.10	+2.58
GB-199-NL-1	2	0.0	3494	19	65	2333	-2.87	+2.28
GB-199-WB							-3.06	+2.53
GB-199-WB		1.7	3566	17	126	1698	-3.04	+2.58
GB-200-SL-1	3	0.0	3992	25	266	1942	-3.28	+2.69
GB-200-SL-2	2	0.8	3961	16	78	2354	-2.97	+2.69
GB-200-WB		1.2	4591	5	187	1770	-3.27	+2.83
GB-215-SL-1	2	0.0	976	17	119	1884	-3.05	+2.56
GB-215-NL-2	2						-2.74	+2.84
GB-216-NL-1	2	1.5	3292	38	77	1431	-5.39	-1.54
GB-217-NL-1	2	0.0	5445	9	98	2288	-5.58	-4.98
GB-236A-SL-1	2	1.2	5427	98	82	1506	-4.11	+1.91
GB-236A-NL-2	1	2.3	5301	66	65	1507	-3.67	+1.97
GB-236B-NL-1	2	0.5	4542	61	226	1845	-4.13	+1.33
GB-236-WB		1.7	5503	189	170	1603	-4.40	+1.92
GB-236-M		16.6	9050	2747	8210	1346	-6.06	-2.66
GB-237-SL-1	2	0.0	4837	78	359	1841	-4.21	+1.63
GB-237-WB		1.6	2724	133	389	1795	-4.18	+1.87
GB-240-NL-1	2	1.2	5015	22	73	2092	-3.33	+1.90
GB-240-WB		1.8	5332	97	240	1733	-3.60	+2.13
GB-242-SL-1	3	15.6	5218	180	314	1549	-4.07	+1.55
GB-242-NL-2	2	3.7	4934	128	172	1536	-3.69	+1.61
GB-242-SL-3	3	0.0	9283	247	639	1729	-6.89	+1.07

GB-242-WB		3.0	5265	295	971	1397	-4.72	-1.40
GB-242-M		2.9	9405	3273	6050	1267	-5.71	-3.47
GB-245A-NL-1	2	2.8	7951	8	32	2706	-2.83	+2.70
GB-245B-NL-1	2	1.0	7691	26	122	2535	-3.01	+2.21
GB-245-WB		1.1	8201	22	336	1295	-3.36	+2.58
GB-246A-SL-1	2	0.0	4480	7	50	2372		
GB-246A-SL-2	3	5.2	6284	105	2066	844	-3.23	+1.63
GB-246B-NL-1	2	1.9	4960	21	530	1518	-3.73	+1.09
GB-246-WB		12.4	6993	20	86	1750	-3.49	+1.63
GB-247-NL-1	2	0.3	4176	22	159	2319	-4.00	+0.76
GB-247-WB		0.9	4191	40	262	1731	-4.18	+1.87
GB-248A-NL-1	2	0.0	5124	14	400	2433	-3.08	+2.43
GB-248B-NL-1	2	0.0	5291	20	337	2202	-4.04	+1.33
GB-248-WB		14.9	6233	15	124	1759	-3.90	+2.91
GB-249A-SL-1	3	10.4	5785	64	1243	1587	-3.04	+2.25
GB-249A-NL-2	2	0.8	5785	36	0	1606	-2.94	+1.23
GB-249B-SL-1	3	0.0	4614	41	3469	1992	-4.04	+1.33
GB-249-WB		18.1	6049	60	158	1499	-3.62	+1.77
GB-249-M		9.7	4635	253	768	1225	-5.29	+1.43
GB-251-SL-1	3	2.5	9942	152	5775	1891	-5.38	+1.33
GB-253-SL-1	3	0.7	4947	50	208	1012	-5.64	-1.63
GB-254-SL-1	3	0.0	4537	20	102	1899	-5.80	+0.46
GB-254-WB		0.8	3803	16	58	1371	-5.65	+0.76
GB-255-SL-1	3	0.0	4845	22	59	1549	-7.10	-0.03
GB-256-SL-1	3	0.7	6336	146	6053	1507	-6.32	-2.29
GB-259-1-SL-1	2	1.9	2164	46	46	1216	-3.12	+8.69
GB-259-2-SL-1	2	0.0	1342	50	34	1636	-2.89	+8.60
GB-260-1-SL-1	3	0.6	3616	27	32	837	-10.29	+1.59
GB-260-2-NL-1	2	1.1	3481	29	51	690	-11.34	+1.18
GB-261-1-SL-1	3	0.9	3710	24	91	1510	-11.20	+1.71
GB-261-2-SL-1	3	0.9	3651	27	60	1447	-11.54	+1.15
GB-261-3-NL-1	2	0.5	3000	30	352	1793	-11.30	+0.09
GB-262-SL-1	3	0.0	5142	47	47	1274	-3.98	+5.00
GB-264-NL-1	2	0.7	5507	6	199	1848	-6.01	-3.72
Ru-1-NL-1	1	1.0	1177	31	2722	614	-4.16	+4.94
Ru-2-NL-1	1	1.2	978	31	2390	569	-3.74	+5.83
Ru-3-NL-1	1	1.3	629	117	5285	545	-3.94	+5.41
Ru-5-NL-1	1	0.6	749	8	1567	569	-3.66	+6.00
Ru-6-NL-1	1	0.0	514	5	57	651		
Ru-8-NL-1	1	3.0	714	20	1458	420	-3.12	+5.43
Ru-9-NL-1	1	3.8	793	24	3125	1357	-3.59	+4.37
Ru-10-NL-1	1	3.9	1109	109	4699	577	-3.59	+5.98
Ru-11-NL-1	1	0.4	637	18	851	655	-3.31	+6.23
Ru-12-NL-1	1	2.9	609	221	10210	525	-3.85	+5.96
Ru-13-NL-1	1	0.7	3980	18	790	1403	+0.67	+3.34
Ru-14-1-NL-1	1	2.0	604	25	518	443	+0.81	+3.13
Ru-14-2-NL-1	1	3.0	3093	52	13866	516	-0.75	+3.41

Ru-15-NL-1	1	1.0	3508	8	194	1081	+0.95	+3.35
Ru-16-NL-1	1	0.0	3674	12	105	1000	+0.88	+3.00
Ru-17-NL-1	1	0.0	4157	15	290	1101	+1.48	+3.88
E-1-1-SL-1	2	0.0	1364	130	1136	617	-2.89	+5.56
E-1-2-SL-1	3	2.7	1488	169	1210	1022	-3.58	+5.23
E-1-3-NL-1	1	2.5	836	26	204	823	-2.01	+5.91
E-1-4-NL-1	1						-2.80	+5.66
E-39-SL-1	2						-2.57	+4.98
E-42-NL-1	1	0.0	786	27	460	556	-1.52	+5.16
E-42-WB		4.5	1502	152	1597	775	-3.14	+4.92
E-42-M		26.7	3386	552	13257	1522	-6.16	+3.15
E-57-NL-1	1	0.0	561	15	75	616	-1.54	+5.33
E-62A-NL-1	1	0.0	649	15	136	770	-1.63	+5.11
E-62B-NL-1	1	2.5	571	19	145	660	-1.64	+5.13
E-62C-NL-1	1	0.0	745	34	235	613	-1.60	+4.84
E-72-SL-1	2	0.7	655	17	258	448	-2.22	+4.47
E-79-SL-1	2	1.2	971	8	84	512	-3.30	+4.82
E-86-SL-1	3	0.0	734	26	105	660	-5.12	+5.37
E-93-NL-1	2	2.5	749	25	165	711	-1.21	+6.50
E-95A-NL-1	1	0.0	950	150	400	750	-1.47	+6.10
E-95B-NL-1	2	0.8	902	20	123	748	-1.36	+5.78
E-100-NL-1	2	1.5	1041	25	76	508	-1.27	+5.09
E-121-SL-1	2	0.6	1031	23	170	777	-2.86	+5.57
E-121-WB		3.7	1441	12	636	799	-2.89	+5.75
E-122-NL-1	2	0.0	993	20	207	960	-2.54	+5.80
E-124-SL-1	3	0.0	6923	154	1404	2442	-5.16	+4.97
E-125-NL-1	2	0.6	1076	15	204	363	-2.64	+5.47
E-126-NL-1	1	0.9	892	15	139	685	-2.51	+5.78
E-127-NL-1	2	0.6	1043	29	443	300	-2.81	+5.72
E-129-NL-1	2	1.4	1137	10	103	859	-2.49	+5.74
E-132-NL-1	1	1.1	600	11	80	618	-2.43	+5.76
E-134-SL-1	3	0.0	1274	94	566	400	-2.30	+5.87
E-135A-SL-1	2	0.0	1652	44	336	556	-3.33	+5.56
E-135B-NL-1	1	0.0	1541	19	150	639	-1.48	+5.28
E-135C-NL-1	2	1.0	893	13	121	587	-2.49	+5.42
E-138-SL-1	2	0.0	701	7	104	424	-2.57	+4.07
E-138-WB		1.4	1312	77	869	780	-3.78	+4.15
E-142-NL-1	1	0.0	779	41	41	289	-2.47	+5.88
E-142-WB		5.6	1406	150	1848	502	-2.56	+1.93
E-158A-NL-1	2	2.4	1304	39	405	622	-2.09	+6.12
E-158B-SL-1	3						-1.99	+5.81
E-160-SL-1	3	1.5	1550	25	663	600	-2.74	+5.41
E-162-NL-1	1	1.3	895	25	67	608	-2.33	+5.94
E-163-NL-1	2	0.0	1165	15	154	903	-2.26	+6.00
E-166-NL-1	2	2.2	867	16	73	613	-2.21	+5.84
E-178-NL-1	2						-1.76	+5.75
E-179A-NL-1	2	0.0	495	71	330	826	-2.27	+5.78

E-179B-NL-1	1						-2.21	+6.00
E-179C-NL-1	2	4.1	767	46	276	552	-2.14	+5.76
E-180-NL-1	2	0.6	725	45	219	619	-2.02	+5.56
E-181-SL-1	3	1.5	1218	83	618	655	-2.24	+5.69
E-182A-NL-1	2	0.0	948	38	189	568	-1.79	+5.63
E-182B-NL-1	2	0.0	733	22	93	747	-1.97	+5.86
E-183-NL-1	2	0.0	1009	30	125	539	-1.66	+5.51
E-185-NL-1	1	0.0	560	44	254	669	-2.06	+5.53
E-187A-SL-1	3	0.6	1468	237	818	3784	-2.27	+5.48
E-187B-NL-1	2	1.3	677	32	263	836	-1.88	+5.86
E-189-NL-1	2	0.0	625	42	354	354	-2.33	+5.82
E-226-SL-1	3	2.8	978	18	236	652	-3.39	+5.82
E-234-NL-1	2	0.7	1094	28	209	748	-1.98	+5.78
E-236-NL-1	1	0.0	1198	16	97	627	-1.85	+6.18
E-246A-NL-1	1	0.0	899	7	142	977	-1.93	+6.08
E-246B-NL-1	1	0.0	875	14	169	673	-2.24	+6.16
E-251-NL-1	2						-2.19	+4.70
E-252-NL-1	2	0.0	1206	18	210	804	-2.22	+5.74
E-255-NL-1	1	1.0	1641	38	177	1313	-2.27	+4.59
E-281-NL-1	2	0.5	661	28	131	606	-3.81	+6.08
E-282-NL-1	1						-3.08	+5.89
E-287-NL-1	2						-3.48	+5.92
E-289-NL-1	2	0.2	803	29	189	690	-3.24	+6.24
E-290-NL-1	2	0.0	904	34	153	299	-3.95	+5.73
E-292A-SL-1	2	10.8	659	55	110	220	-4.68	+5.93
E-292B-NL-1	1	0.6	487	23	90	434	-3.50	+5.97
E-293A-SL-1	3	0.0	5350	192	6225	1475	-4.54	+3.66
E-293B-NL-1	1	0.5	913	11	148	753	-3.46	+6.45
E-311-SL-1	3	2.9	2277	171	58	655	-3.31	+5.15
E-315-NL-1	1	0.0	813	12	77	706	-3.03	+6.69
E-317-NL-1	1	0.6	452	15	113	753	-2.97	+6.28
E-321-NL-1	1	1.4	1772	21	84	588	-2.47	+5.96
E-322-NL-1	1	0.0	963	14	61	656	-3.27	+6.26
E-322-WB		3.5	1429	36	315	624	-3.25	+6.42
E-323-NL-1	1	1.0	734	18	97	518	-2.60	+5.91
E-323-NL-2	1	1.8	738	11	196	629	-2.76	+6.06
E-323-WB		0.1	1062	52	316	543	-3.68	+2.97
E-323-M		16.9	6587	655	6771	957	-7.25	+5.22
E-324A-NL-1	1	0.0	1166	35	943	761	-3.16	+6.55
E-324A-NL-2	1	0.7	1137	0	0	744	-3.10	+6.36
E-324A-NL-3	1	0.3	1081	22	285	774	-2.97	+6.52
E-324A-NL-4	1	1.1	1131	10	129	561	-3.04	+6.49
E-324A-NL-5	1	1.0	1115	15	10	514	-3.06	+6.46
E-324B-NL-1	1	0.6	876	17	153	704	-3.00	+6.23
E-324C-NL-1	1	0.6	931	22	203	722	-3.31	+6.10
E-324D-NL-1	1	0.6	1147	8	248	761	-3.02	+6.09
E-324E-NL-1	1	0.9	868	10	174	777	-3.04	+6.35
E-324F-NL-1	1	1.3	860	13	231	738	-3.13	+6.34

E-324G-NL-1	1	0.3	896	17	162	697	-3.10	+6.34
E-324H-NL-1	1	0.4	927	16	212	716	-3.02	+6.47
E-324I-NL-1	1	1.2	1086	19	229	724	-3.08	+6.51
E-324J-NL-1	1	1.3	947	43	450	703	-3.20	+6.37
E-324J-NL-2	1	1.6	1310	25	295	680	-2.97	+6.56
E-324K-NL-1	1	1.8	1215	61	605	655	-3.28	+6.43
E-324-WB		0.1	1060	50	315	545	-4.56	-1.09
E-324-M		37.2	5033	438	12175	1153	-6.50	+4.10
E-327A-NL-1	1	3.8	1201	24	58	613	-0.83	+6.13
E-327B-NL-1	2	1.8	1289	26	130	732	-1.75	+5.95
E-331-NL-1	2	0.8	1063	23	160	594	-2.18	+5.42
E-334-NL-1	2	0.0	1699	32	353	897	-1.11	+6.24
Th-1-SL-1	3	0.0	1438	21	110	747	-7.14	+4.14
Ti-6-SL-1	3	0.0	625	112	342	2083	-1.22	+5.22
Ti-6-WB		6.1	1005	598	967	1594	-1.02	+5.49
Ti-7-NL-1	2	1.9	754	126	961	1679	-0.70	+5.37
Ti-7-NL-2	2	0.9	791	246	99	1693	-0.64	+5.12
Ti-7-WB		4.8	791	126	563	1664	-1.11	+4.75
Ti-8-NL-1	2	0.7	552	23	259	1734	-0.64	+5.47
Ti-8-BL-2	4	0.2	811	197	504	1232	-2.22	+4.72
Ti-8-SL-3	3	0.8	653	31	31	1888	-0.96	+5.41
Ti-8-WB		0.7	885	439	554	1351	-1.44	+4.81
Ti-9-SL-1	3	1.4	962	1091	344	1881	-1.06	+4.76
Ti-9-WB		7.5	967	4388	1415	1362	-1.79	+3.51
Ti-12-SL-1	3	0.0	422	50	50	1152	-0.52	+4.25
Ti-16-SL-1	3	1.4	469	46	51	923	-0.68	+4.40
Ti-19-SL-1	3	3.2	5273	1600	14227	236	-3.78	+2.63
Ti-26-NL-1	1	0.0	745	28	75	566	-0.58	+5.51
Ti-26-WB		10.8	1053	142	216	289		
Ti-33-NL-1	2	0.0	574	123	109	287	-0.59	+5.46
Ti-44-NL-1	1	0.0	525	30	128	525	-0.60	+5.86
Ti-44-WB		3.4	421	28	133	438	-0.12	+5.95
Ti-50-NL-1	1	0.0	1185	106	144	874	-0.54	+5.68
Ti-52-NL-1	1	0.0	736	107	123	475	-0.85	+5.64
Ti-54-SL-1	3	0.4	931	310	54	607	-1.20	+5.68
Ti-54-WB		2.4	1234	418	182	351	-0.90	+5.68
Ti-67A-NL-1	2	0.0	475	21	117	530	-0.53	+5.64
Ti-67B-NL-1	1	2.8	667	95	238	357	-0.81	+5.67
Ti-67-WB		8.9	2094	592	2358	342	-0.73	+5.23
Ti-80-NL-1	2	0.0	390	75	98	480	-0.25	+6.16
Ti-80-WB		4.2	3224	3780	5844	300	-2.33	+2.97
Ti-82-NL-1	2	0.0	475	174	195	691	+0.26	+5.82
Ti-82-SL-2	3	0.0	5299	3714	12418	553	-3.83	+1.80
Ti-82-IC-3	4	0.0	4111	2062	10566	443	-4.08	+2.04
Ti-82-IC-4	4	2.8	4632	1492	13184	290	-4.83	+0.82
Ti-82-WB		1.0	2983	1380	5113	293	-3.19	+2.42

Ti-83A-NL-1	1	1.0	550	38	215	367	+0.16	+6.04
Ti-83B-NL-1	1	0.6	567	29	215	492	+0.09	+6.06
Ti-83B-NL-2	1	1.2	458	64	451	423	0.00	+6.00
Ti-83B-NL-3	1	1.0	457	43	268	401	+0.09	+6.07
Ti-83B-IC-4	4	3.7	6056	2360	14596	242	-5.62	+1.62
Ti-83-WB		2.3	3483	1779	10353	398	-2.70	+3.78
Ti-83-M		2.0	5267	2171	10768	288	-5.91	+1.47
Ti-84-NL-1	2	5.1	462	155	17	492	-0.79	+5.72
Ti-84-WB		0.6	507	199	65	472	-0.72	+5.79
Ti-90-NL-1	1	0.0	630	144	130	239	-0.78	+5.62
Ti-93-NL-1	2	0.0	437	49	68	388	-0.48	+6.29
Ti-93-WB		2.2	3835	2413	1713	244	-0.51	+5.77
Ti-97-NL-1	1	0.0	581	21	37	429	-0.64	+5.42
Ti-98-SL-1	2	0.0	570	138	285	554	-0.99	+5.85
Ti-98-WB		7.2	3042	2151	5994	259	-1.71	+4.18
Ti-99-SL-1	2	2.3	404	231	15519	240	-0.81	+5.86
Ti-103-SL-1	3	0.6	1228	213	750	397	-0.53	+5.59
Ti-114-NL-1	2	0.0	930	75	69	1834	-0.82	+5.28
Ti-114-WB		5.0	2680	851	7158	1391	-0.51	+4.83
Ti-115A-NL-1	1	0.0	412	6	97	2494	-0.52	+5.46
Ti-115B-NL-1	1	0.4	458	15	29	3304	-0.60	+5.61
Ti-116-NL-1	2						+0.15	+6.78
Ti-123-SL-1	2	0.6	1745	89	657	1047	-1.48	+3.49
Ti-126-SL-1	3	1.2	1642	133	1206	1102	-1.62	+3.57
Ti-127A-SL-1	2	0.0	1492	82	886	1206	-1.50	+3.50
Ti-127B-SL-1	2	0.0	1480	100	158	1228	-1.62	+3.71
Ti-131-SL-1	2	32.4	1711	80	1321	940	-0.59	+5.09
Ti-135A-NL-1	1	3.7	556	8	56	818	-0.48	+5.70
Ti-135B-NL-1	1	3.6	1113	28	38	462	-0.80	+5.21
Tu-3-SL-1	3						-1.55	+2.91
Tu-7-SL-1	2	5.0	1818	94	468	1698	-1.67	+3.47
Yu-1-SL-1	3	5.7	799	17	187	859	-5.28	+5.57
Yu-2-SL-1	3	0.0	1215	140	1262	1098	-7.62	+4.97
Yu-3-SL-1	3						-4.25	+6.18
Yu-5-SL-1	3	0.0	1225	102	1327	637	-7.78	+5.65
Yu-6-SL-1	3	0.0	803	12	147	968	-3.56	+6.16
Yu-8-NL-1	2	0.0	669	24	96	526	-3.65	+5.55
Yu-9A-NL-1	1	0.1	1006	10	39	648	-3.35	+6.30
Yu-9B-NL-1	2						-3.98	+5.88
Yu-10-SL-1	3	1.0	3506	73	579	2392	-6.91	+3.70
Yu-22-SL-1	2	0.6	4191	67	441	2479	-6.92	+2.75
Yu-24-NL-1	2	0.0	567	8	241	521	-3.29	+5.69
Yu-25-SL-1	3	0.0	719	7	99	581	-3.79	+6.24
Yu-26-NL-1	2	0.2	833	12	75	701	-3.53	+6.30
Yu-27-SL-1	3						-5.35	+6.22
Yu-28-NL-1	2	0.0	861	6	169	1530	-3.62	+5.81

Yu-30-SL-1	3	1.4	1232	71	473	545	-4.71	+6.19
Yu-34-SL-1	3	0.0	1056	31	76	109	-2.67	+4.88
Yu-40A-SL-1	3	1.6	6897	16	90	937	-3.37	+2.59
Yu-40B-SL-1	3	0.9	8386	14	71	1200	-3.13	+2.03
Yu-46-NL-1	2	5.3	1039	28	84	632	-5.46	+6.03
Ord-1-1-SL-1	2	0.0	2437	42	189	1933	-4.16	+1.38
Ord-1-2-SL-1	2	0.0	3342	136	163	1087	-4.81	+0.89
Ord-1-3-NL-1	1						-3.83	+1.16
Ord-2-NL-1	1	0.0	2981	258	387	1303	-3.97	+1.42
Ord-4-NL-1	1	0.0	3700	167	267	1300	-4.99	+0.23
Ord-5-1-NL-1	1	2.4	1653	41	62	1405	-4.24	+0.79
Ord-5-2-NL-1	1	0.0	1760	33	165	1563	-4.36	+0.63
Ord-5-3-NL-1	1	2.8	2842	50	114	1726	-4.71	+0.32
Ord-5-4-NL-1	1	0.0	2150	25	88	1775	-4.34	+0.36
Ord-6-WB		2.1	3056	369	278	2102		
HH(84)-1-NL-1	1	0.0	1141	54	326	815	-4.08	+1.02
HH(84)-2-NL-1	1	0.0	1426	50	269	1762	-3.73	+1.21
HH(84)-3-NL-1	1	0.0	1281	94	188	1000	-3.78	+1.46
HH(84)-4-NL-1	1	4.2	1391	16	94	1884	-3.63	+1.42
HH(84)-5-NL-1	1	0.6	1052	24	87	1923	-3.63	+1.33
HH(84)-6-NL-1	1	0.0	952	29	131	1853	-3.65	+1.28
HH(84)-7-NL-1	1	0.0	1100	41	170	1740	-3.67	+1.32
HH(84)-8-WB		1.2	1511	205	107	2175		
HH(84)-9-WR		7.2	3423	2363	2217	936		